PRICE $2.00

HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATHKIT®
ASSEMBLY MANUAL

HEATHKIT

FREQUENCY SCALER
MODEL IB-102

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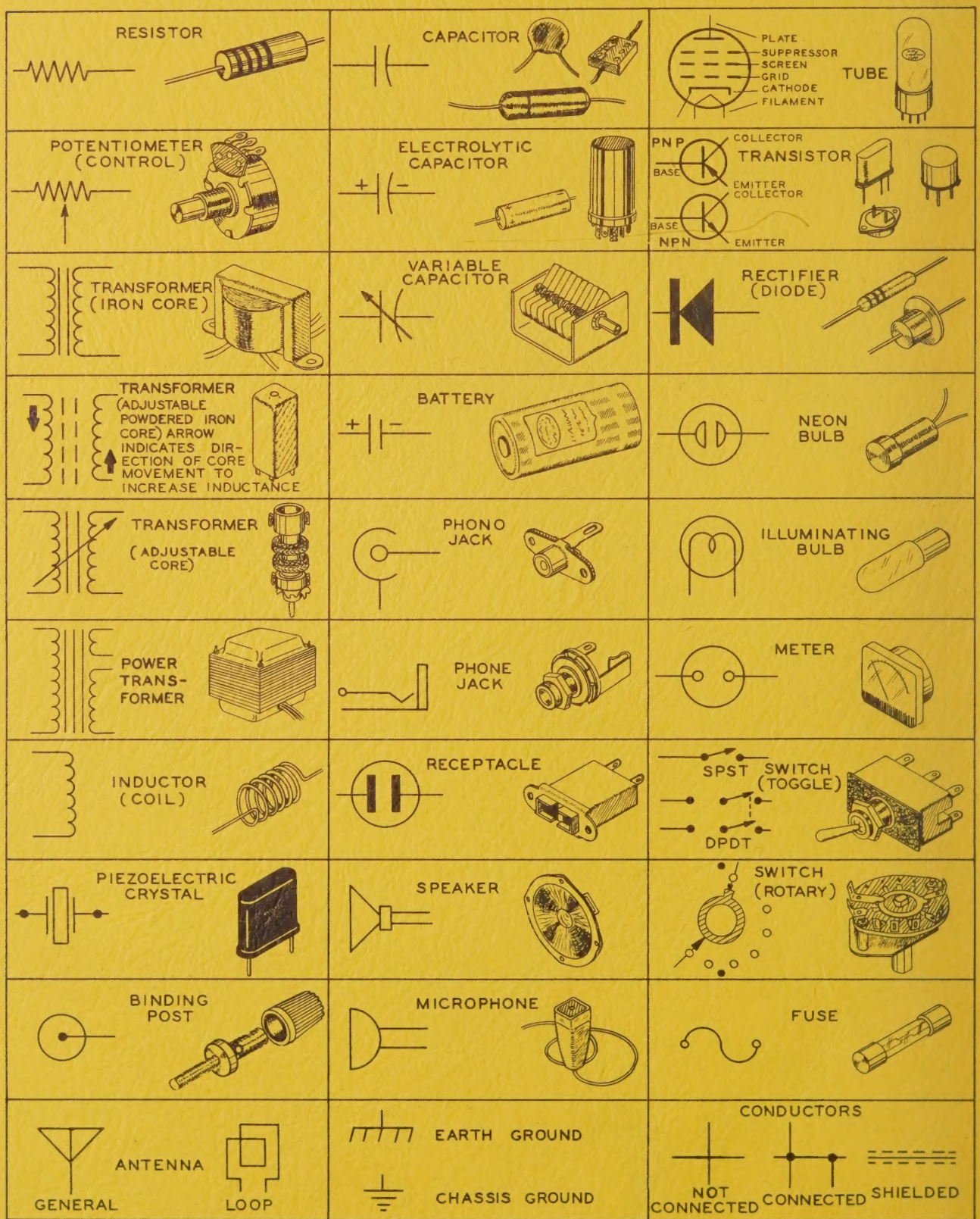
595-1298-02

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.

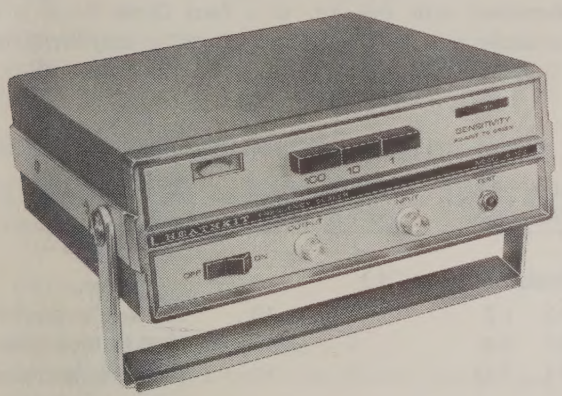


Assembly
and
Operation
of the

HEATHKIT

FREQUENCY SCALER

MODEL IB-102



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HEATH COMPANY
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INTRODUCTION

The Model IB-102 Heathkit Frequency Scaler is used to extend the useful frequency range of a frequency counter. Basically, the Frequency Scaler is a divider which will scale down, by a factor of 10 or 100, any input signal between 2 MHz and 175 MHz. It also has a straight-through mode, making it unnecessary to disconnect the Frequency Scaler from the counter to read the lower frequencies that are within the capabilities of the counter.

Many features make the Frequency Scaler convenient and easy to use. A meter monitors the input level in the divide-by-N mode to indicate if the input level is high enough to provide proper operation. Proper input level can be maintained with the front panel Sensitivity control.

The Frequency Scaler's trim appearance and size make it an ideal companion for the Heathkit Model IB-101 Frequency Counter.

Small and reliable plug-in integrated circuits minimize and simplify maintenance. The regulated power supplies can be operated from either a 110 to 130 or a 220 to 260 volt 50/60 Hz ac power source. The detachable test leads and line cord, along with a three-detent position bail-type handle, make the Scaler easily transportable. The unique bail-type handle can be used to position the Scaler at a desirable viewing angle.

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

Check each part against the following parts list. The key numbers correspond to the numbers on the Parts Pictorial (fold-out from Page 5). To order replacement parts, refer to the Price Each column and use the Parts Order form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" in the "Kit Builders Guide."

KEY No.	PART No.	PARTS Per Kit	PRICE Each	DESCRIPTION
RESISTORS				
1/2-Watt				
A1	1-143	1	.10	2.7 Ω (red-violet-gold)
A1	1-41	1	.10	10 Ω (brown-black-black)
A1	1-62	1	.10	51 Ω (green-brown-black)
A1	1-2	1	.10	68 Ω (blue-gray-black)
A1	1-3	2	.10	100 Ω (brown-black-brown)
A1	1-45	2	.10	220 Ω (red-red-brown)
A1	1-42	1	.10	270 Ω (red-violet-brown)
A1	1-4	2	.10	330 Ω (orange-orange-brown)
A1	1-63	1	.10	510 Ω (green-brown-brown)
Resistors (Cont'd.)				
A1	1-7	1	.10	680 Ω (blue-gray-brown)
A1	1-9	1	.10	1000 Ω (brown-black-red)
A1	1-11	1	.10	1500 Ω (brown-green-red)
A1	1-90	1	.10	2000 Ω (red-black-red)
A1	1-13	1	.10	2700 Ω (red-violet-red)
A1	1-14	1	.10	3300 Ω (orange-orange-red)
A1	1-16	2	.10	4700 Ω (yellow-violet-red)
A1	1-20	2	.10	10 kΩ (brown-black-orange)
A1	1-22	1	.10	22 kΩ (red-red-orange)
A1	1-69	1	.10	18 kΩ (brown-gray-orange)
A1	1-35	1	.10	1 MΩ (brown-black-green)

KEY No.	PART No.	PARTS Per Kit	PRICE Each	DESCRIPTION
Other Resistor				
A2	3-7-5	1	.15	11Ω, 5-watt
CAPACITORS				
Disc				
B1	21-3	1	.10	10 pF
B1	21-14	5	.10	.001 μF
B1	21-27	1	.10	.005 μF
B1	21-16	4	.10	.01 μF
Electrolytic				
B2	25-200	2	.50	.68 μF tantalum
B3	25-149	2	.50	5 μF
B4	25-186	1	.45	1.6 μF
B4	25-211	1	.85	33 μF tantalum
B5	25-98	1	.25	50 μF
B5	25-175	1	.55	250 μF
B5	25-111	1	2.35	1000 μF
B5	25-154	1	1.35	2500 μF
Other Capacitors				
B6	27-85	4	.25	.22 μF Mylar*
B7	26-93	1	1.65	1.5-13 pF trimmer

DIODES-TRANSISTORS-INTEGRATED CIRCUITS

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number.
3. Part number and type number.
4. Part number with a type number other than the one listed.

KEY No.	PART No.	PARTS Per Kit	PRICE Each	DESCRIPTION
C1	56-75	2	2.25	5.1 V zener diode, 1N5338B
C1	56-71	1	5.00	6.2 V zener diode, 1N825A
C1	56-20	2	.25	Germanium diode,1N295
C1	57-65	6	.20	Silicon diode, 1N4002
C2	417-118	2	.40	Transistor, 2N3393
C3	417-154	2	1.65	Transistor, 2N2369
C4	417-167	1	1.65	Transistor, UC734
C4	417-258	1	.60	Transistor, TIS87
C5	417-175	1	1.45	Transistor, TA2911
C6	442-2	1	7.70	Integrated circuit, SN4985N
C6	443-1	1	3.00	Integrated circuit, SN7400

*DuPont Registered Trademark

KEY No.	PART No.	PARTS Per Kit	PRICE Each	DESCRIPTION
Diodes-Transistors-Integrated Circuits (cont'd.)				
C6	443-7	1	9.70	Integrated circuit, SN7490N
C6	443-38	1	5.00	Integrated circuit, MC1023P
C6	443-39	1	5.00	Integrated circuit, MC1034P
C6	443-40	1	3.75	Integrated circuit, MC1013P
C6	443-41	2	5.00	Integrated circuit, MC1027P
CONTROLS-SWITCHES				
D1	10-200	1	.50	2000 Ω control
D2	10-289	1	.30	2000 Ω control
D3	10-285	1	1.45	100 Ω control
D4	60-45	1	.50	SPST rocker switch
D5	64-31	1	1.45	SPST pushbutton switch
D6	64-77	1	2.45	DPDT 3-section pushbutton switch
FUSE BLOCK-TERMINAL STRIPS-CONNECTORS				
E1	422-1	1	.25	Fuse block
E2	431-57	1	.10	2-lug terminal strip
E3	431-10	1	.10	3-lug terminal strip
E4	432-59	2	1.65	BNC connector (with hardware)
E5	432-76	1	.30	Line cord connector
E6	432-144	126	.01	Integrated circuit connector
METAL PARTS				
F1	90-505-1	2	1.65	Cabinet shell (top and bottom)
F2	200-608	1	2.05	Main chassis
F3	200-609	1	.60	Power supply chassis
F4	203-788	1	2.05	Front panel
F5	203-789-1	1	.70	Rear panel
F6	204-1199	1	.10	Meter mounting bracket
F7	204-1201	1	.35	Handle bracket
F8	205-780	2	1.05	Trim plate
F9	211-51	1	1.55	Handle
F10	205-141	2	.10	Tool plate
F11	208-6	1	.15	Capacitor mounting clip
F12	215-44	1	.65	Transistor heat sink
F13	257-15	4	.10	Eyelet
F14	258-106	1	.20	Flat spring

KEY No.	PART No.	PARTS Per Kit	PRICE Each	DESCRIPTION
LINE CORD-CABLE-WIRE				
	89-30	1	1.25	Line cord
	134-236	1	4.35	Cable assembly (with BNC connectors on both ends)
	340-11	1	.05/ft	Bare wire
	343-9	1	.10/ft	Coaxial cable
	344-16	1	.05/ft	Red wire
	344-51	1	.05/ft	Brown wire
HARDWARE				
#3 Hardware				
G1	250-49	5	.05	3-48 x 1/4" screw
G2	252-1	5	.05	3-48 nut
G3	254-7	6	.05	#3 lockwasher
#4 Hardware				
H1	250-285	4	.05	4-40 x 1/4" screw
H2	250-273	1	.05	4-40 x 3/8" screw
H3	252-2	1	.05	4-40 nut
H4	254-9	5	.05	#4 lockwasher
#6 Hardware				
J1	250-303	2	.15	6-32 x 1/4" screw
J2	250-89	13	.05	6-32 x 3/8" screw
J3	250-434	12	.05	6-32 x 3/8" flat head screw
J4	250-79	4	.05	6-32 x 1-1/4" screw
J5	252-3	23	.05	6-32 nut
J6	253-27	3	.05	#6 flat washer
J7	254-1	26	.05	#6 lockwasher
J8	255-103	1	.10	6-32 threaded spacer
J9	259-1	1	.05	#6 solder lug
Other Hardware				
K1	254-14	1	.05	1/4" lockwasher
K2	252-7	2	.05	Control nut
K3	253-75	3	.05	3/8" flat washer
K4	259-27	2	.05	3/8" solder lug
K5	266-194	1	.40	Handle detent
MISCELLANEOUS				
L1	45-57	2	.30	10 μH choke
L2	54-272	1	4.05	Power transformer
L3	75-90	1	.10	Fish paper insulator
	85-1131-1	1	3.25	Circuit board
L4	211-52	1	.90	Handle grip
L5	261-29	4	.05	Foot
L6	407-160	1	3.45	Meter
L7	412-31	1	.50	Lamp
L8	421-33	1	.30	1/4 ampere slow-blow fuse
L9	462-224	1	.25	Knob
	390-352	1	.30	Heath label
	390-904	1	.25	Top front panel label
	390-354	1	.25	Bottom front panel label
	391-34	1		Blue and white label
L10	490-5	1	.10	Nut starter
L11	490-71	1	.90	Alignment tool
	597-308	1		Kit Builders Guide
	597-260	1		Parts Order Form
				Solder (additional 3' rolls of solder can be ordered under part number 331-6 for $.15 each.)
		1	2.00	Manual (See front cover for part number.)

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties and rates of exchange.

ASSEMBLY NOTES

Before starting to assemble this kit, read the Kit Builders Guide for complete information on wiring, soldering, and step-by-step assembly procedures.

NOTE: Because the Frequency Scaler operates at high frequencies, it is important that all wires and component leads be kept short and positioned as shown.

Resistors will be called out by their resistance value in Ω, kΩ, or MΩ, and color code. Use 1/2-watt resistors unless directed otherwise.

Capacitors will be called out by their capacitance value (in pF or μF) and type (disc, mica, or electrolytic).

STEP-BY-STEP ASSEMBLY

CIRCUIT BOARD

Install the components on the circuit board by following the steps on Pictorials 1 through 8. Position all parts as shown.

( ) Position the circuit board as shown in the identification drawing at the top of Pictorial 1.

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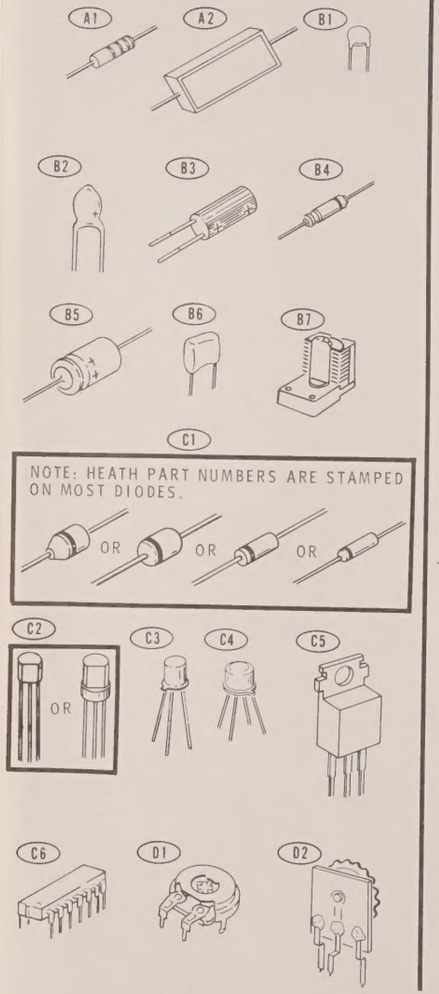
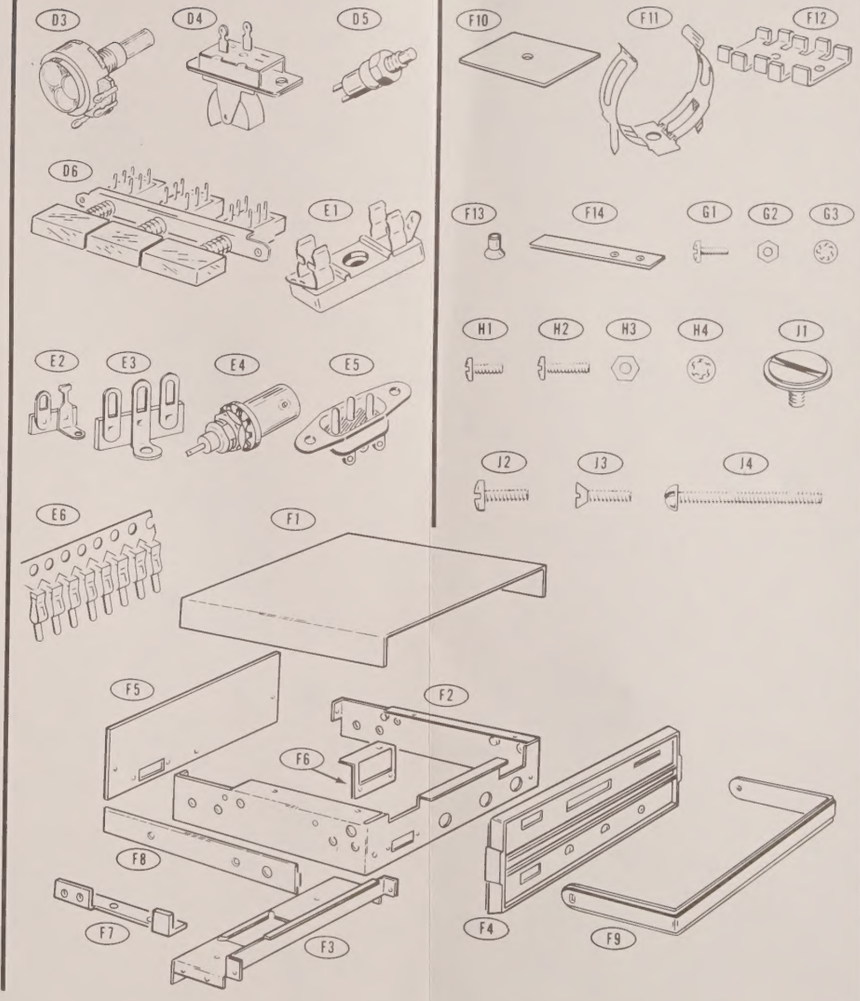
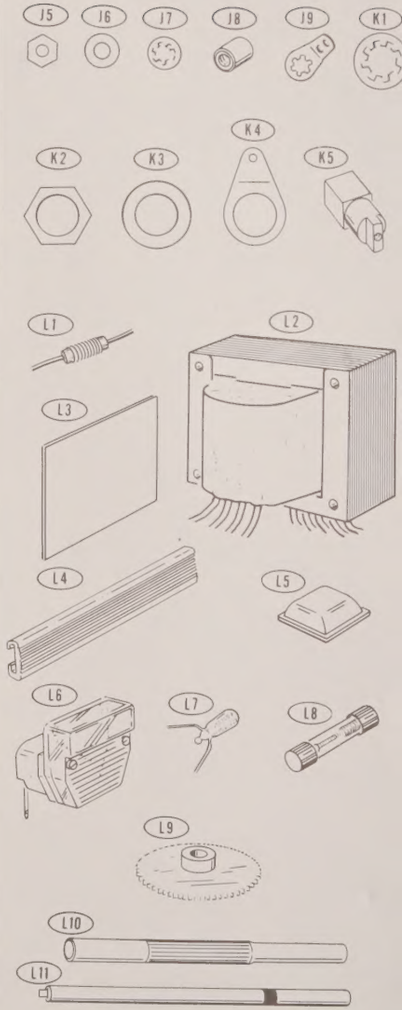
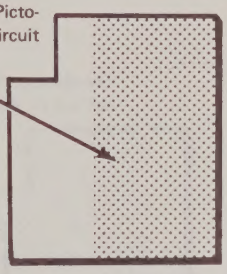
PARTS PICTORIAL







The steps performed in this Pictorial are in this area of the circuit board.



IDENTIFICATION DRAWING

START

( ) 100 Ω (brown-black-brown).

( ) 2.7 Ω (red-violet-gold).

( ) 1N5338B zener diode (#56-75) at ZD2. Note position of banded end.

( ) 330 Ω (orange-orange-brown).

( ) 3300 Ω (orange-orange-red).

( ) Solder all leads to the foil and cut off the excess lead lengths.

( ) 1N825A zener diode (#56-71) at ZD3. Note position of banded end.

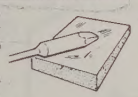
( ) 2700 Ω (red-violet-red).

( ) 1000 Ω (brown-black-red).

( ) 18 kΩ (brown-gray-orange).

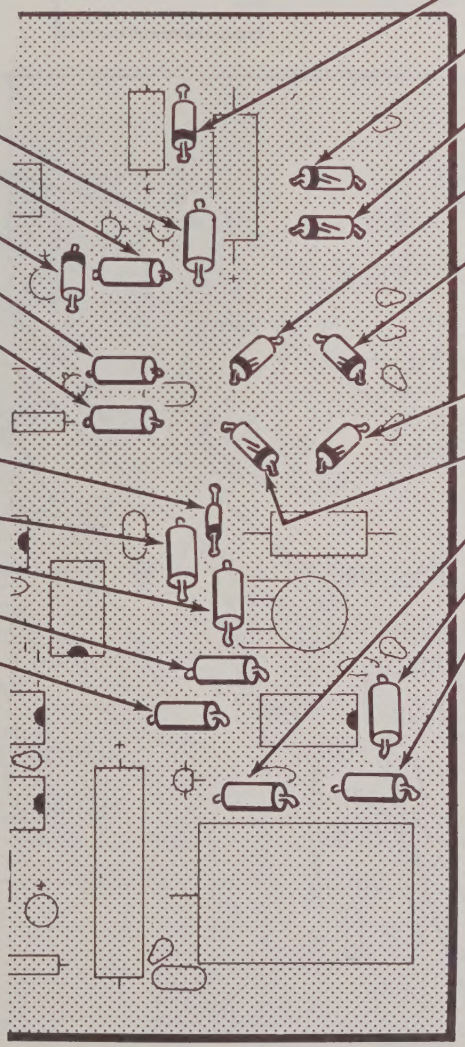
( ) 10 kΩ (brown-black-orange).

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN...



WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

( ) Solder all leads to the foil and cut off the excess lead lengths.



CONTINUE

( ) 1N5338B zener diode (#56-75) at ZD1. Note position of banded end.

( ) 1N4002 silicon diode (#57-65) at D8.

( ) 1N4002 silicon diode (#57-65) at D7.

( ) 1N4002 silicon diode (#57-65) at D6.

( ) 1N4002 silicon diode (#57-65) at D5.

( ) Solder all leads to the foil and cut off the excess lead lengths.

( ) 1N4002 silicon diode (#57-65) at D3.

( ) 1N4002 silicon diode (#57-65) at D4.

( ) 4700 Ω (yellow-violet-red).

( ) 1500 Ω (brown-green-red).

( ) 220 Ω (red-red-brown).

( ) Solder all leads to the foil and cut off the excess lead lengths.

PICTORIAL 2

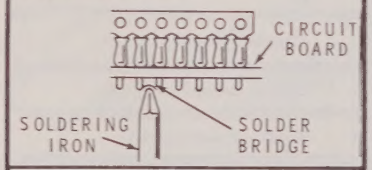
START

See "Soldering Iron Considerations" (fold-out from Page 6).

NOTE: In the following steps, you will be instructed to cut off and install strips of IC (integrated circuit) connectors. But, since all locations do not have consecutive holes, it will be necessary, at times, to remove one or more connectors from a strip before it can be installed. Where this occurs, do not install one connector at a time. Instead, cut off a strip of connectors that is long enough to have a connector for each mounting hole. Then position the strip at the indicated location on the circuit board and remove any connector that does not have a corresponding hole in the circuit board. The individual connectors will break off easily when bent.

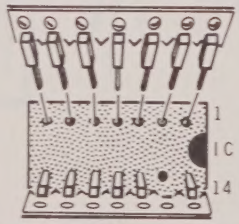
Before soldering the connectors to the foil, be sure each strip is perpendicular to the board and that the connecting band is towards the outline on the board. Solder each connector strip as it is installed.

If a solder bridge occurs between foils, clean the soldering iron tip, and then hold it between the two points that are bridged until the excess solder flows down the tip of the soldering iron.



NOTE: The number of connectors in a strip, as called out in the following steps, will include ALL connectors - including any that have to be removed.

( ) Two seven-connector strips at IC3.

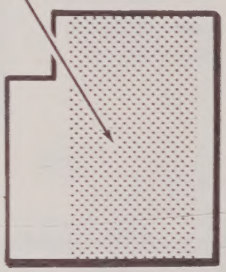


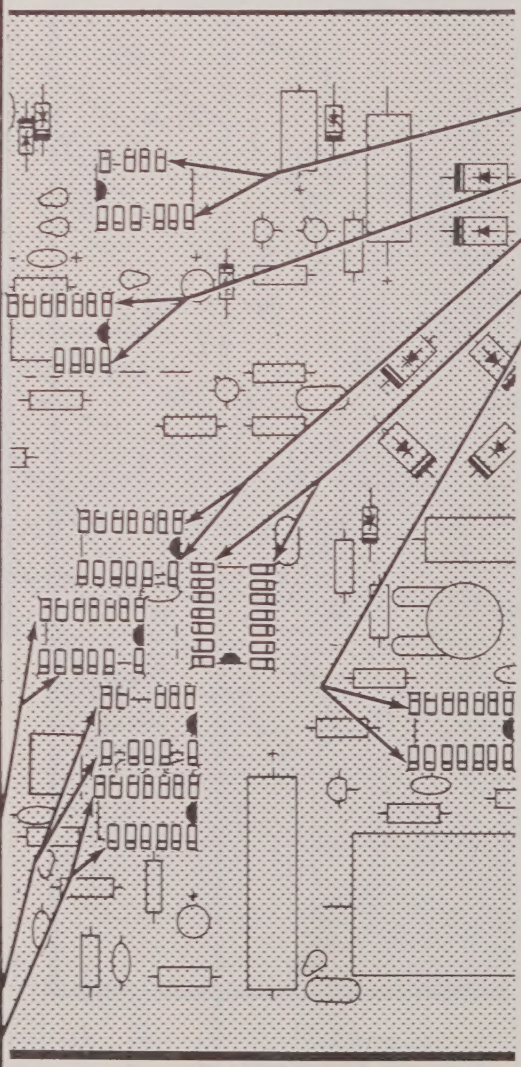
( ) Two seven-connector strips at IC2.

( ) One seven-connector strip and one six-connector strip at IC1.

The steps performed in this Pictorial are in this area of the circuit board.

IDENTIFICATION DRAWING





KEEP YOUR SOLDERING IRON TIP CLEAN

CONTINUE

( ) One five-connector strip and one seven-connector strip at IC7.

( ) One seven-connector strip and one four connector strip at IC6.

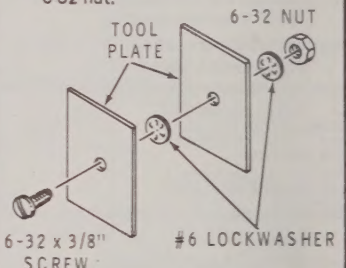
( ) Two seven-connector strips at IC4.

( ) Two seven-connector strips at IC5.

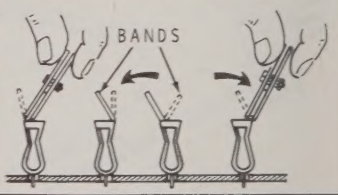
( ) Two seven-connector strips at IC8.

( ) Check to see that all connectors are soldered to the foil and that no solder bridges exist.

( ) Assemble the two tool plates together as shown. Use a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut.



( ) Remove the connecting bands from the IC connector strips. Do this by first bending the band "inward," then bend it "outward" as shown.



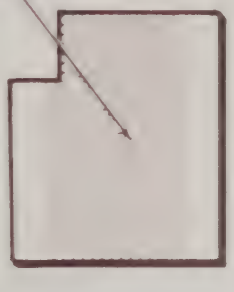
PICTORIAL 3

SOLDERING IRON TIP

START

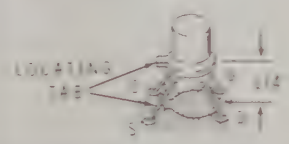
The steps performed in this Pictorial are in this area of the circuit board.

IDENTIFICATION DRAWING

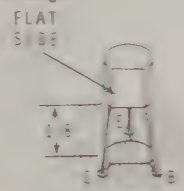


CONTINUE

( ) UC734 transistor (#417-167) at Q3. Position this transistor over its outline on the circuit board and place the S, C, G, and D leads of the transistor into the corresponding S, C, G, and D holes of the circuit board. Position the transistor 1/4" above the circuit board. Solder each lead to the foil and cut off the excess lead lengths.

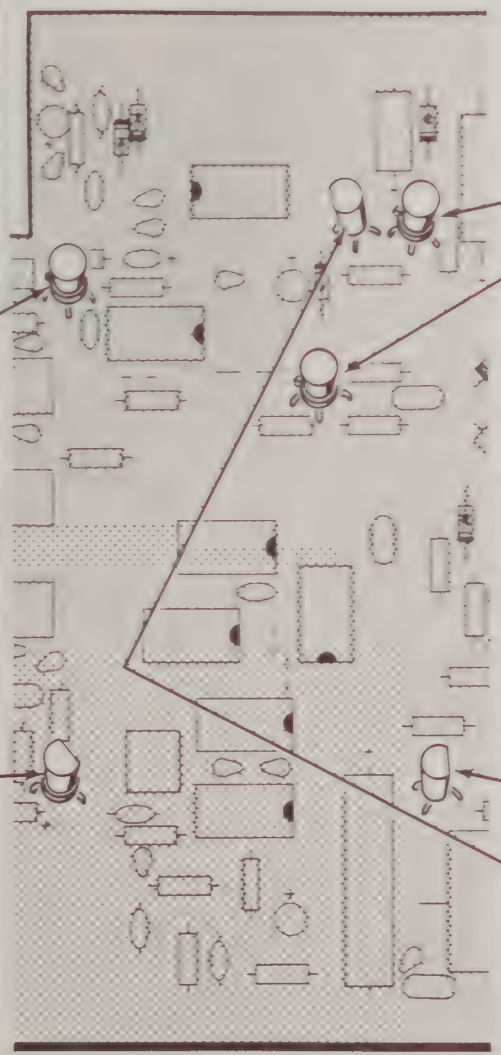


( ) TIS87 transistor (#417-258) at Q1. Position the transistor over its outline on the circuit board and place the C, E, and B leads of the transistor into the corresponding C, E, and B holes of the circuit board. Position the transistor 1/8" above the circuit board. Solder each lead to the foil and cut off the excess lead lengths.

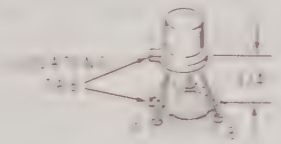


FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN.

WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH



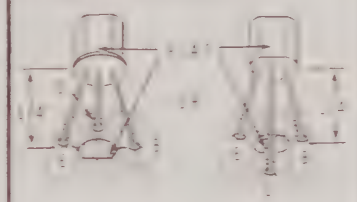
NOTE: When installing the following type of transistor, position it over its outline on the circuit board and place the C, B, and E leads of the transistor into the corresponding C, B, and E holes of the circuit board. Position the transistor 1/4" above the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



( ) 2N2369 transistor (#417-154) at Q7

( ) 2N2369 transistor (#417-154) at Q2

NOTE: When installing the following type of transistor, position it over its outline on the circuit board and place the B, C, and E leads of the transistor into the corresponding B, C, and E holes of the circuit board. Position the transistor 1/4" above the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



( ) 2N3393 transistor (#417-118) at Q4

( ) 2N3393 transistor (#417-118) at Q6

( ) Check to see that all connections are soldered and that the excess lead lengths are cut off.

NOTE: If the large bare wire was wrapped around the tip of your soldering iron, remove it at this time. Use a pair of pliers to avoid being burned.

PICTORIAL 4

START

( ) 1000 µF electrolytic.

( ) 50 µF electrolytic.

NOTE: When installing disc capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil. Also the leads of the Mylar capacitors may be coated with a clear film. If any soldering problem is encountered with these capacitors, apply more heat to the leads to melt this film.

( ) .01 µF disc.

( ) 5 µF electrolytic.

( ) .001 µF disc.

( ) 5 µF electrolytic.

( ) .68 µF tantalum.

( ) 33 µF tantalum.

( ) 10 pF disc.

( ) .22 µF Mylar.

( ) .22 µF Mylar.

( ) .001 µF disc.

( ) Solder all leads to the foil and cut off the excess lead lengths.

( ) .005 µF disc.

( ) .22 µF Mylar.

( ) .001 µF disc.

( ) .001 µF disc.

( ) 1.6 µF electrolytic.

( ) .01 µF disc.

( ) .01 µF disc.

( ) .01 µF disc.

( ) .68 µF tantalum.

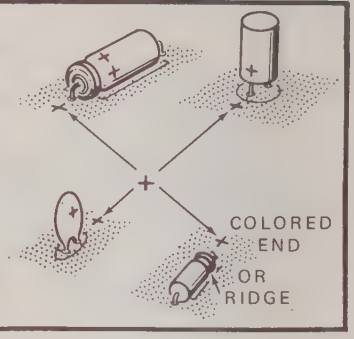
( ) 250 µF electrolytic.

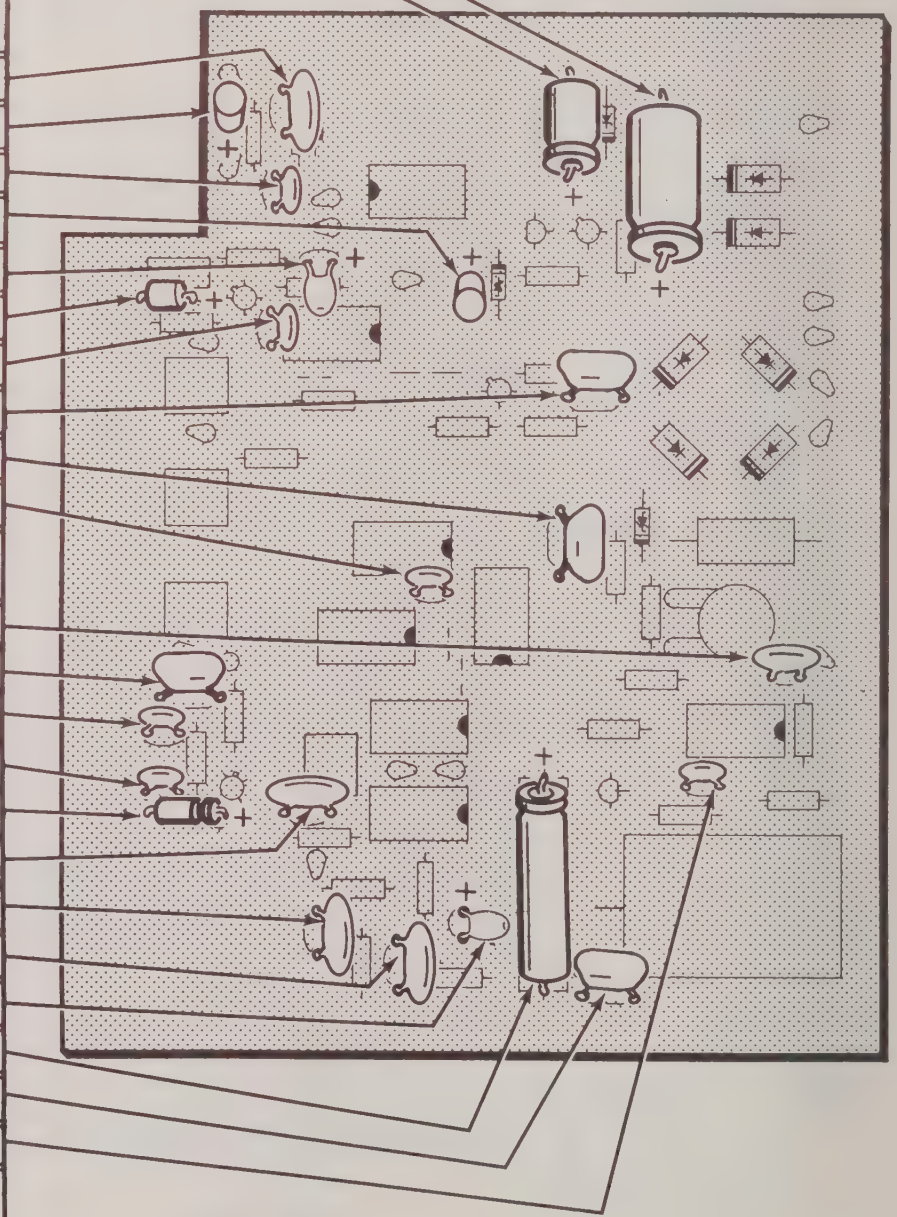
( ) .22 µF Mylar.

( ) .001 µF disc.

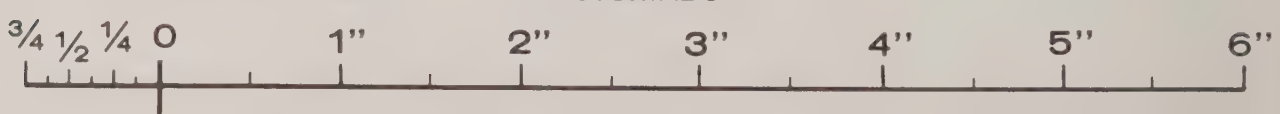
( ) Solder all leads to the foil and cut off the excess lead lengths.

NOTE: In some of the steps in this Pictorial, you will be instructed to install electrolytic and tantalum capacitors. Always match the positive (+) mark or ridge on the capacitor with the positive (+) mark on the circuit board.



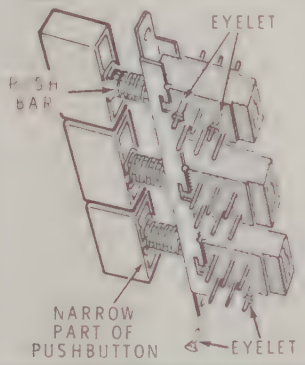


PICTORIAL 5

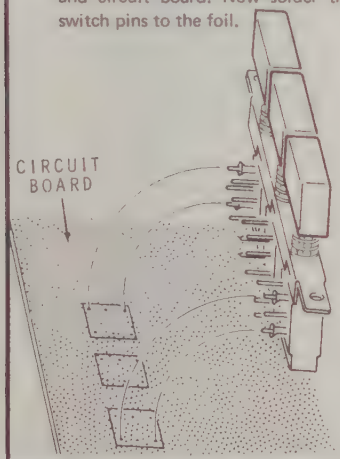


START

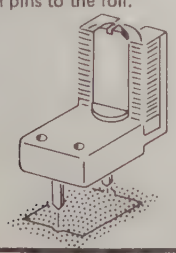
( ) DPDT, 3-section, pushbutton switch. Hold the switch so the narrowest part of the pushbutton, as measured from the push bar of the switch to the outside edge of the pushbutton, is positioned down as shown. Then install an eyelet all the way onto each of the four indicated outside pins of the switch. Pinch the eyelets with a pair of pliers to keep them on the switch pins. These eyelets are to provide proper spacing between the switch and circuit board.



( ) Place the pins of this switch into the holes of the circuit board, pushing the switch tight against the board. The eyelets serve as spacers and must be kept tight against the switch and circuit board. Now solder the switch pins to the foil.

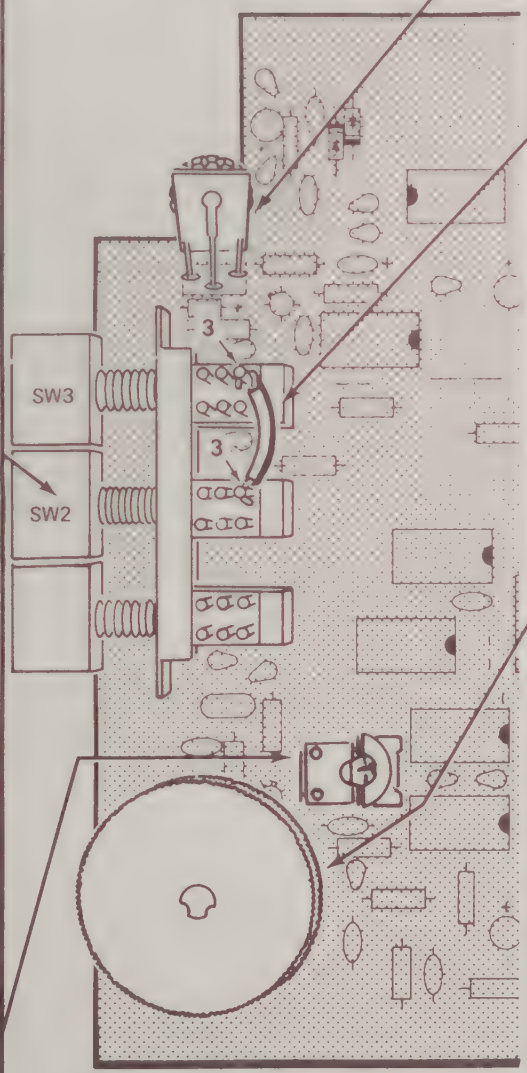


( ) 1.5 pF trimmer capacitor. Solder both pins to the foil.



The steps performed in this Pictorial are in this area of the circuit board.

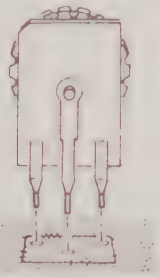
IDENTIFICATION DRAWING



PICTORIAL 6

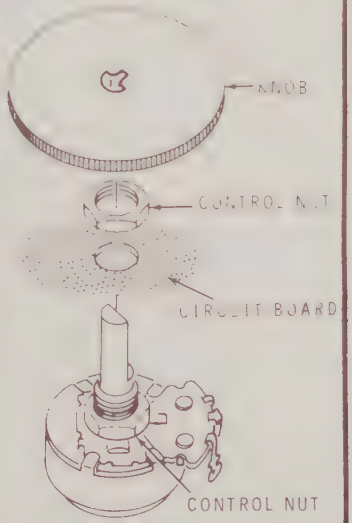
CONTINUE

( ) 2000 Ω control (#10-289). Solder all three pins to the foil.

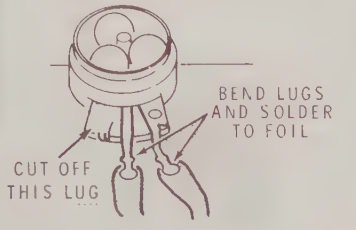


( ) Remove 1/4" of insulation from both ends of a 1-1/2" brown wire. Connect this wire from pin 3 of switch SW3 (S-1) to pin 3 of switch SW2 (S-1).

( ) 100 Ω control (#10-285). Use two control nuts. Then install knob. Turn the first nut all the way down on the threads of the control.

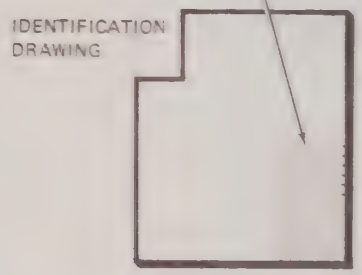


( ) Turn the circuit board over and bend the two indicated control lugs against the indicated foils. Then solder these two control lugs to their foils. Reposition the control if necessary. Cut off the unused lug.



The steps performed in this Pictorial are in this area of the circuit board.

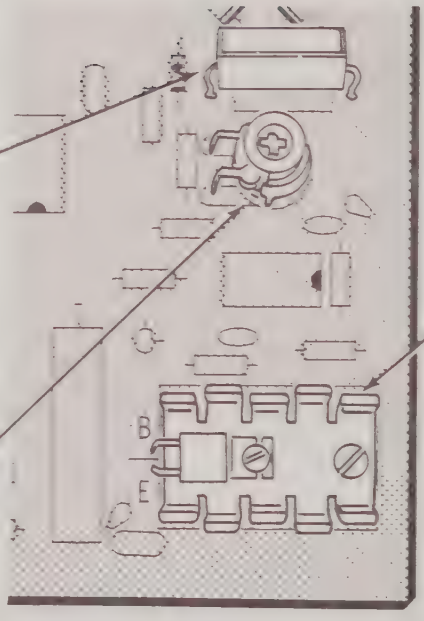
IDENTIFICATION DRAWING



START

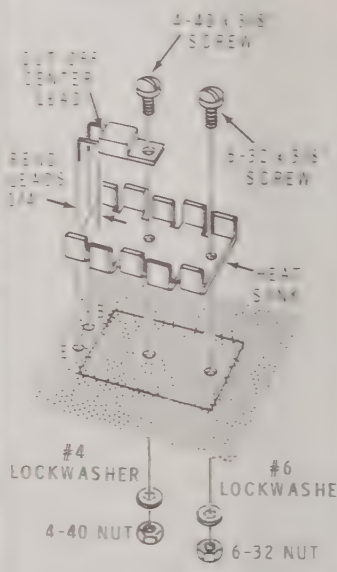
( ) 11 Ω 5-watt resistor. Position the body of the resistor 1/8" above the circuit board. Solder both leads to the foil and cut off the excess lead lengths.

( ) 2000 Ω control (#10-200). Solder all four lugs to the foil.



CONTINUE

( ) TA2911 transistor (#417-175) and transistor heat sink at Q5.



( ) Solder both leads to the foil. Be sure the leads do not touch the heat sink.

PICTORIAL 7

START

( ) Remove 1/4" of insulation from both ends of the following lengths of brown wire:

3", 1-1/2", 1-1/2"

Connect one end of each of these wires to the circuit board as follows:

( ) 3" brown wire to hole S (S-1).

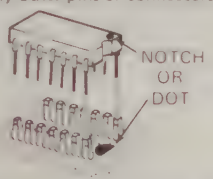
( ) 1-1/2" brown wire to hole R (S-1).

( ) 1-1/2" brown wire to hole P (S-1).

This completes the parts installation on the circuit board except for the IC's. Check to see that all connections are soldered and that no solder bridges exist. There are a number of unused holes which will be used later.

In the following steps, you will be instructed to install the IC's (integrated circuits) into their connectors mounted on the circuit board. Install each of the IC's as follows:

Position the notch or dot end of the IC over the dot screened on the circuit board. Then insert the IC leads into the IC connectors. DO NOT solder the IC to the connectors. DO NOT cut off any unused pins of an IC and be sure they do not touch any other pins or connectors.



NOTE: Should it ever become necessary to remove an IC from its connectors, slide a screwdriver blade under the IC; then gently lift the IC out of the connectors.

( ) IC SN7490N (=443-7) at IC7.

( ) IC SN7400 (=443-1) at IC6.

( ) IC MC1013 (=443-40) at IC4.

( ) IC MC1027 (#443-41) at IC3.

( ) IC MC1027 (#443-41) at IC5.

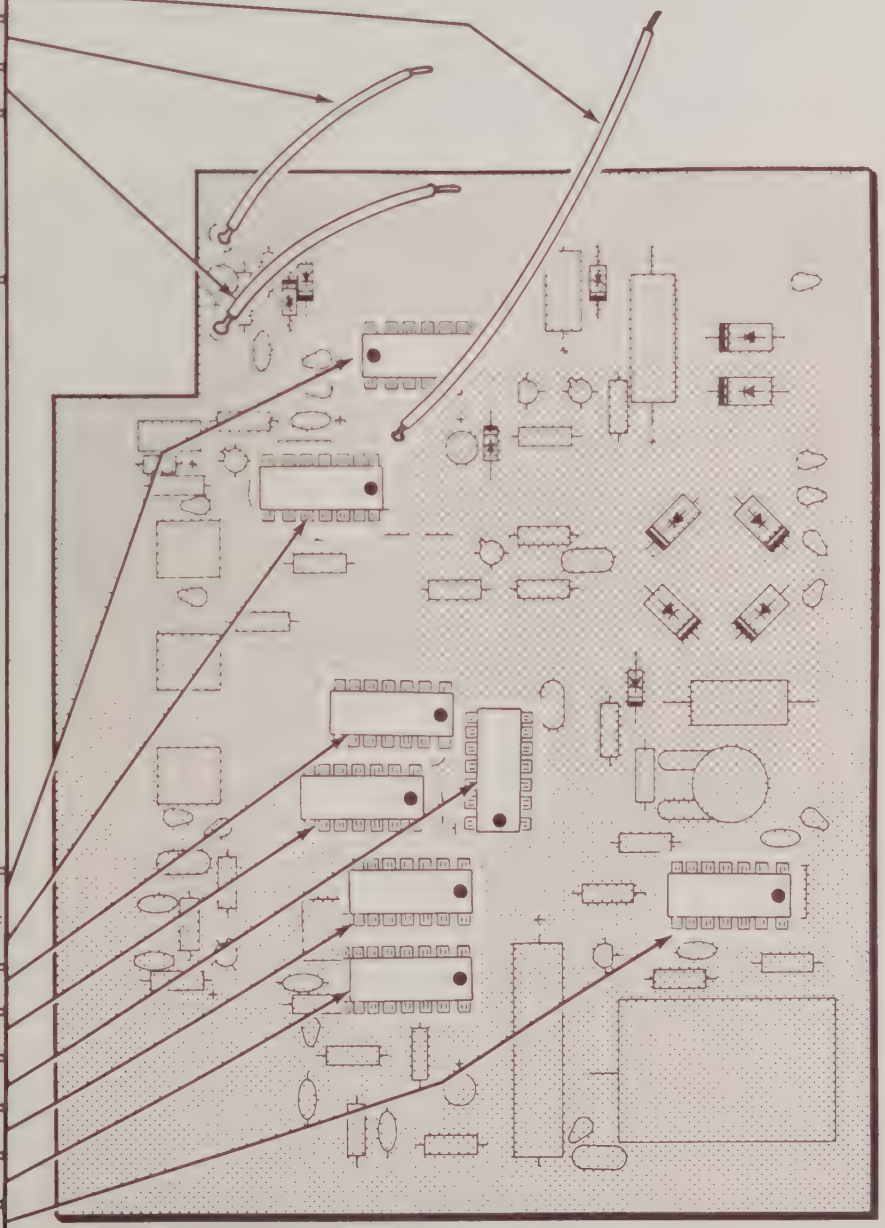
( ) IC MC1034 (#443-39) at IC2.

( ) IC MC1023 (#443-38) at IC1.

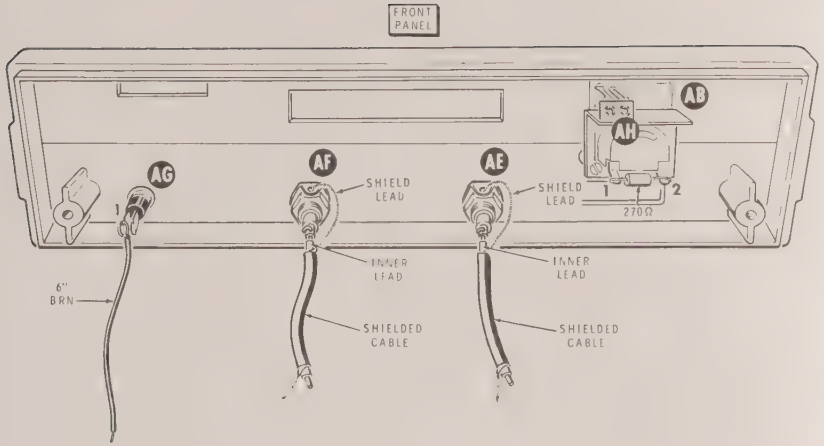
( ) IC SN4985N (#442-2) at IC8.

FINISH

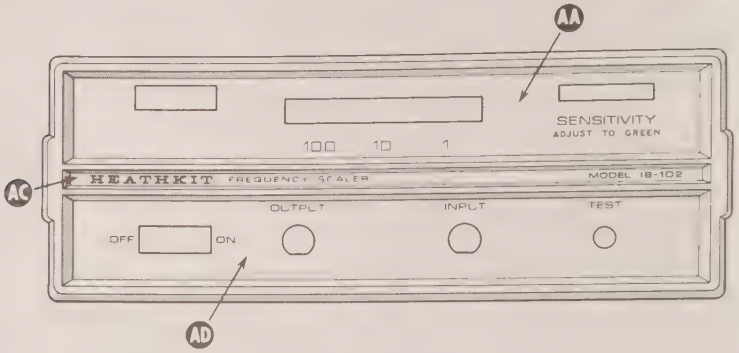
Temporarily set the circuit board aside.



PICTORIAL 8



PICTORIAL 10



PICTORIAL 9

FRONT PANEL ASSEMBLY AND WIRING

Refer to Pictorial 9 for the following steps.

( ) Locate the front panel and position it as shown.

( ) Carefully remove the protective backing from the top front panel label and press the label in place at AA.

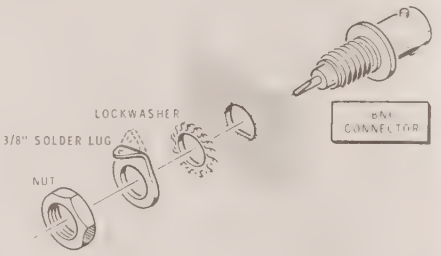
( ) Carefully remove the protective backing from the "Heathkit" label and press it in place at AC.

( ) Carefully remove the protective backing from the bottom front panel label and press it in place at AD.

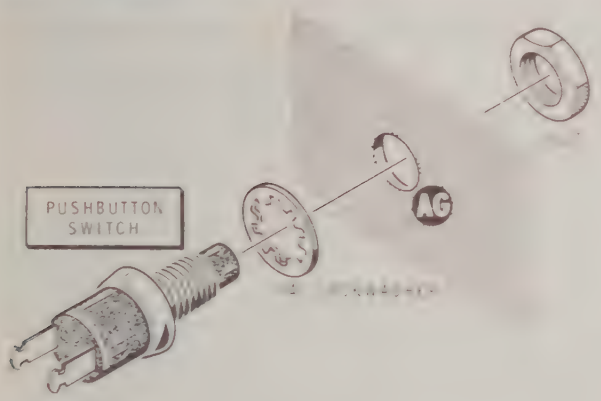
Refer to Pictorial 10 for the following steps.

( ) Refer to Detail 10A and install a BNC connector at AE. Use the nut and lockwasher furnished with the connector and a 3/8" solder lug. Then bend the solder lug as shown.

( ) In the same manner, install a BNC connector at AF.



Detail 10A



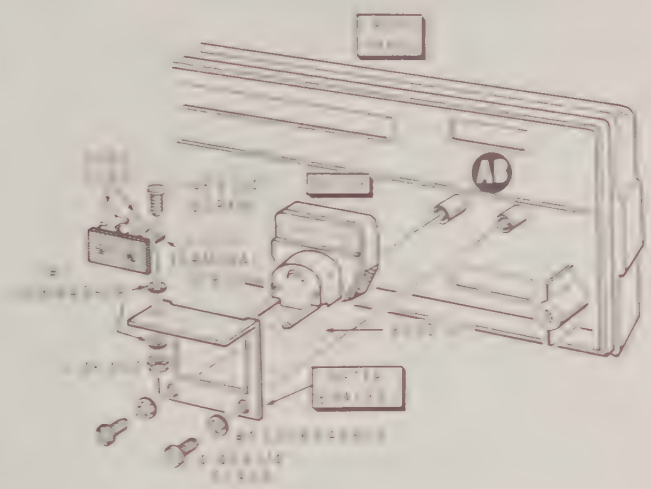
Detail 10B

( ) Refer to Detail 10B and mount the pushbutton switch at AG. Use the nut furnished with the pushbutton switch and a 1/4" lockwasher.

NOTES:

1. Use the plastic nut starter supplied with this kit to hold and start 3-48 and 6-32 nuts on screws. Refer to the "Kit Builders Guide" for further information.

2. The term "hardware" will be used to refer to the screws, nuts, and lockwashers when parts are being mounted in some of the following steps. The phrase "use 3-48 x 1/4" hardware," for example, means to use a 3-48 x 1/4" screw, one or more #3 lockwashers, and a 3-48 nut. Refer to the Detail called out in the step to determine the correct number of lockwashers and the correct way to install the hardware.



Detail 10C

Refer to Detail 10C for the following steps.

( ) Mount a 2-lug terminal strip at AH on the meter mounting bracket. Use 3-48 x 1/4" hardware. Then bend the lugs of the terminal strip as shown.

( ) Carefully remove the very fine shorting wire from the meter lugs (if there is one). Then bend the meter lugs up as shown.

( ) Mount the meter at AB on the front panel with the meter mounting bracket. Use 4-40 x 1/4" screws and #4 lockwashers.

Refer to Pictorial 10 for the following steps.

( ) Prepare a 6" length of brown wire by removing 1/4" of insulation from each end.

( ) Connect one end of the 6" brown wire to lug 1 of pushbutton switch AG (S-1). Wrap the wire around the lug. The other end of the wire will be connected later.

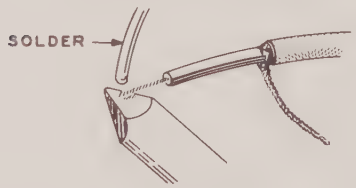
( ) Refer to Detail 10D and prepare both ends of two 3" shielded cables. Be very careful not to pull the inner lead from the cable.

CUT THE CABLE ACCORDING TO THE DIMENSIONS BELOW. PREPARE EACH END AS SHOWN.

TAKING CARE NOT TO CUT THE OUTER SHIELD OF VERY THIN WIRES, REMOVE THE OUTER INSULATION.

PUSH BACK THE SHIELD. USE A POINTED OBJECT TO SEPARATE THE FINE WIRES OF THE SHIELD AS SHOWN. THEN TWIST THESE FINE WIRES TOGETHER.

REMOVE THE INNER INSULATION AND STRETCH OUT THE SHIELD. APPLY A SMALL AMOUNT OF SOLDER TO THE END OF THE SHIELD AND THE INNER LEAD. USE ONLY ENOUGH HEAT FOR THE SOLDER TO FLOW.



Detail 10D

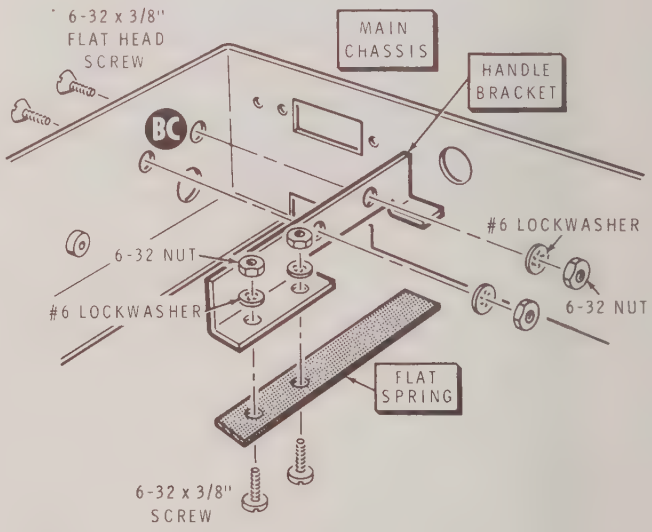
( ) At the end that has the shorter inner lead on one of the 3" shielded cables, connect the inner lead to the center pin of BNC connector AF (S-1) and the shield lead to the solder lug at AF (S-1). The other end of the cable will be connected later.

( ) At the end that has the shorter inner lead on the other 3" shielded cable, connect the inner lead to the center pin of BNC connector AE (S-1) and the shield lead to the solder lug at AE (S-1). The other end of the cable will be connected later.

CAUTION: Be very careful when performing the next step, as the lugs of the meter are quite fragile and can be broken easily.

( ) Cut both leads of a 270 Ω (red-violet-brown) resistor to 3/8". Then connect it between lugs 1 (S-1) and 2 (S-1) of meter AB. Position the resistor as shown.

Set the front panel aside temporarily.



Detail 11A

MOUNTING PARTS ON THE CHASSIS

Refer to Pictorial 11 (fold-out from Page 19) for the following steps.

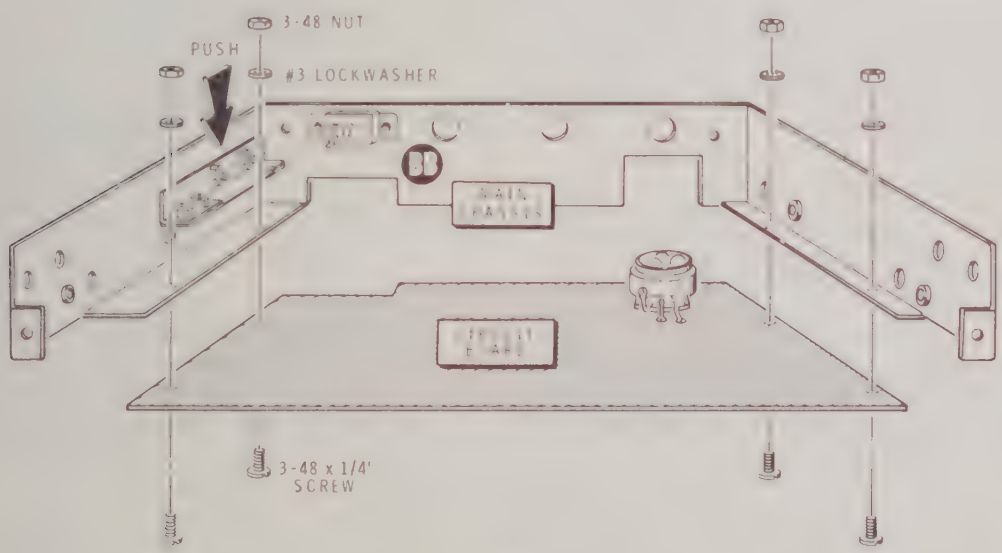
( ) Refer to Detail 11A and mount the flat spring on the handle bracket with 6-32 x 3/8" hardware. Keep the edge of the flat spring parallel to the edge of the handle bracket.

( ) Mount the handle bracket at BC on the main chassis with 6-32 x 3/8" flat head hardware as shown in Detail 11A. Push the bracket as far as possible in the direction of the arrow before tightening the hardware.

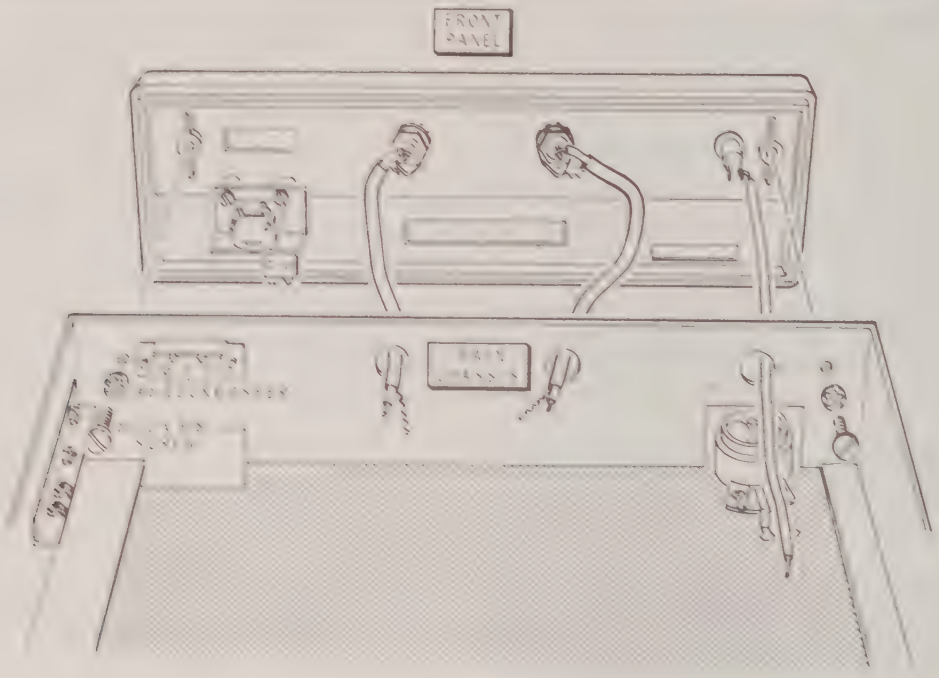
( ) Refer to Detail 11B and mount the SPST rocker switch at BB with 4-40 x 1/4" screws and #4 lockwashers. Be sure to position the switch as shown.

( ) Refer to Detail 11C and mount the circuit board on the main chassis with 3-48 x 1/4" hardware. Be sure not to pinch any wires between the circuit board and chassis. Tighten this hardware only finger tight at this time.

Detail 11B



Detail 11C



Detail 11D

( ) Refer to Detail 11D and mount the front panel on the main chassis with 6-32 x 3/8" screws and #6 lockwashers. Be sure the wires from the front panel pass through the indicated holes in the main chassis and that the pushbutton knobs, the control knob, and the rocker switch knob fit through the appropriate cut-outs of the main chassis.

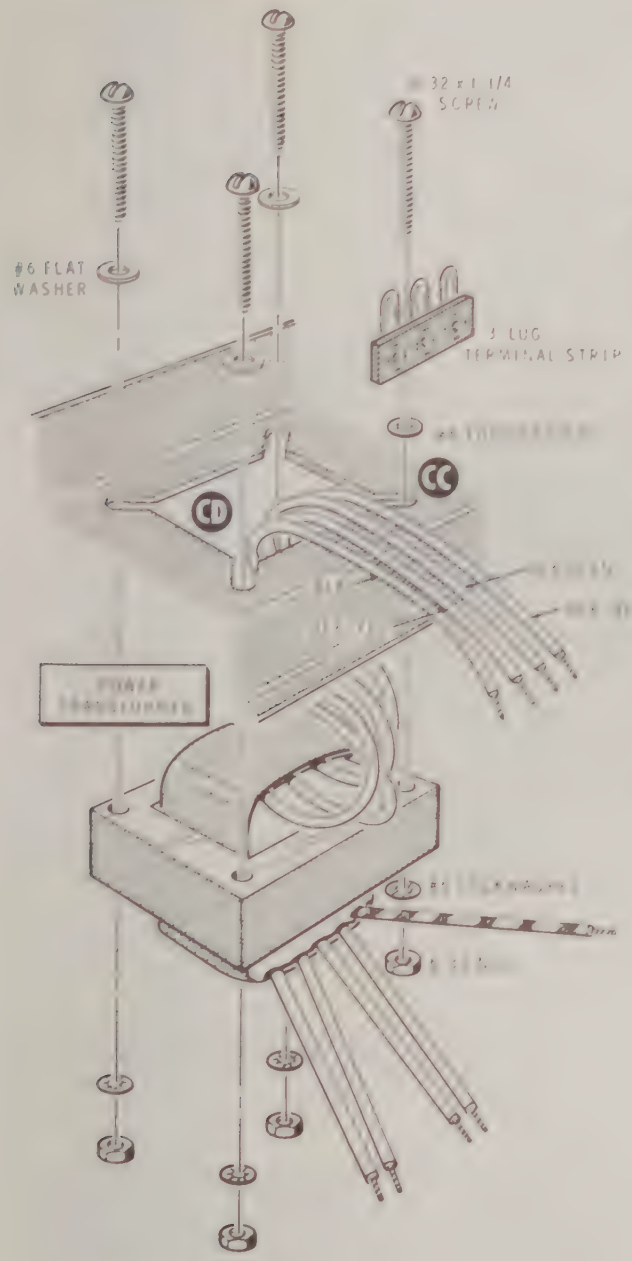
Set the chassis assembly aside temporarily.

Refer to Pictorial 12 for the following steps.

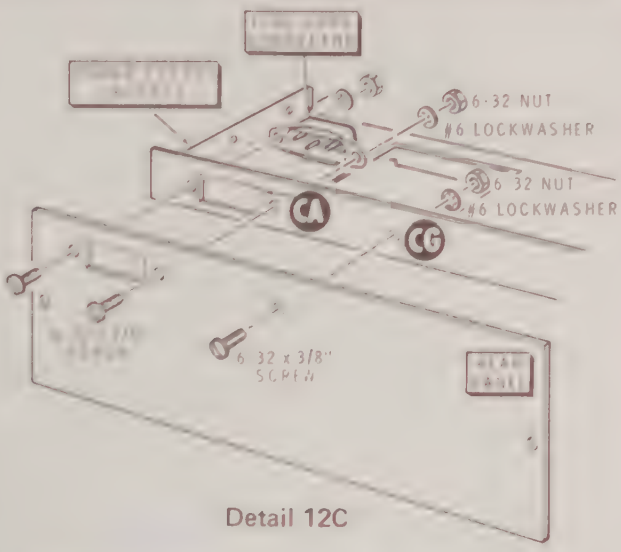
( ) Refer to Detail 12A and install the capacitor mounting clip at CE with 6-32 x 3/8" hardware on the power supply chassis. Position the capacitor mounting clip as shown.

Detail 12A

( ) Refer to Detail 12B and mount the power transformer at CD with a 3-lug terminal strip at CC. Use 6-32 x 1-1/4" hardware with #6 flat washers at the three indicated locations. Pass the indicated color leads through the chassis cut-out as shown.



Detail 12B



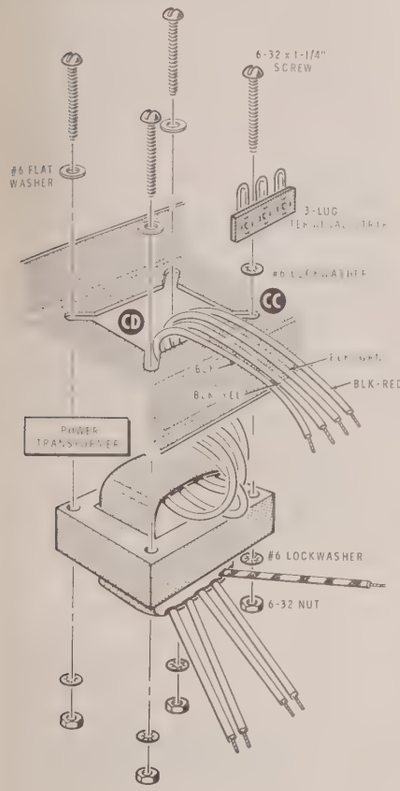
Detail 12C

( ) Mount the rear panel on the power supply chassis with 6-32 x 3/8" hardware at CG. Be sure and align the holes at CA in both pieces with each other. See Detail 12C.

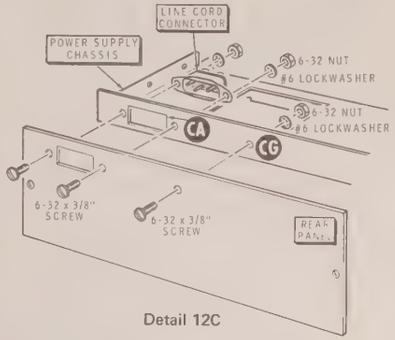
( ) Refer to Detail 12C and mount the line cord connector at CA with 6-32 x 3/8" hardware. Position the connector as shown.

( ) Refer to Detail 12D and mount the fuse block at CB with 6-32 x 3/8" hardware. Do not overtighten the hardware as the fuse block can be broken.

Detail 12D



Detail 12B



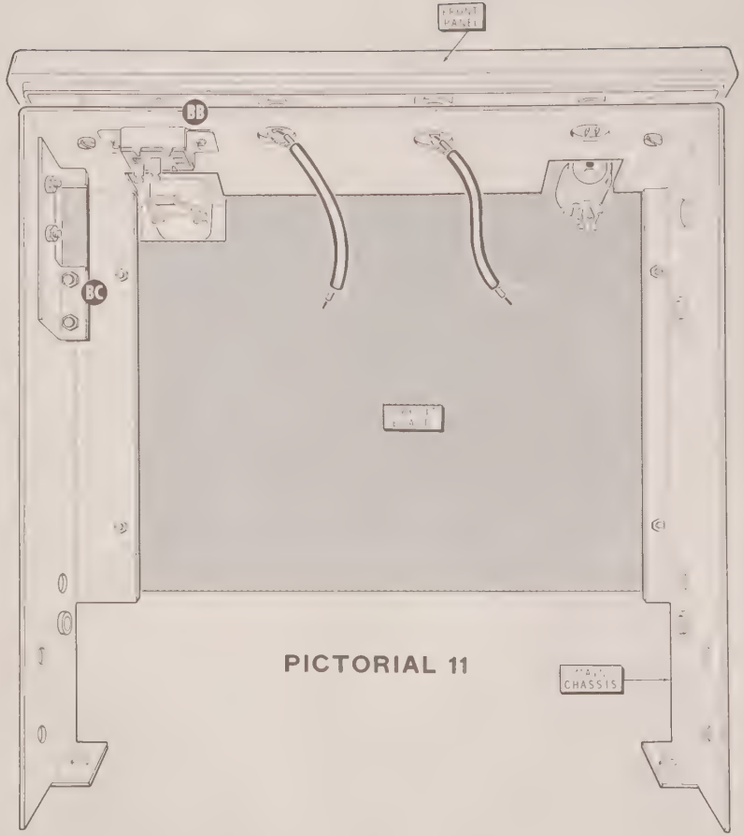
Detail 12C

( ) Mount the rear panel on the power supply chassis with 6-32 x 3/8" hardware at CG. Be sure and align the holes at CA in both pieces with each other. See Detail 12C.

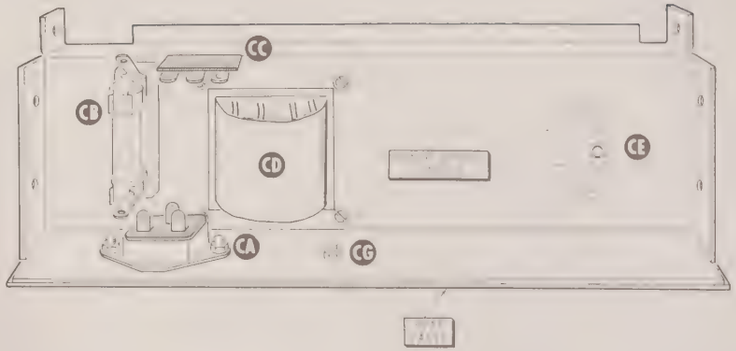
( ) Refer to Detail 12C and mount the line cord connector at CA with 6-32 x 3/8" hardware. Position the connector as shown.

( ) Refer to Detail 12D and mount the fuse block at CB with 6-32 x 3/8" hardware. Do not overtighten the hardware as the fuse block can be broken.

Detail 12D



PICTORIAL 11



PICTORIAL 12

( ) Cut both leads of a 22 kΩ (red-red-orange) resistor to 1". Connect this resistor from lug 2 of pushbutton switch AG (S-1) into hole H in the circuit board (S-1).

( ) Connect the free end of the shielded cable coming from BNC connector AF to the circuit board as follows: Inner lead into hole K (S-1) and the shield lead into hole L (S-1). Be sure none of the fine wires touch any other foil on the circuit board.

( ) Connect the free end of the shielded cable coming from BNC connector AE to the circuit board as follows: Inner lead into hole M (S-1) and the shield lead into hole N (S-1).

( ) Connect the brown wire coming from hole P (in the lettered side of the circuit board) to lug 1 of the meter AB and solder the connection. A resistor is already soldered to the lug.

( ) Connect the brown wire coming from hole R (in the lettered side of the circuit board) to lug 2 of the meter AB and solder the connection. A resistor is already soldered to the lug.

Detail 13B

( ) Refer to Detail 13B and prepare the ends of a 5-1/2" length of shielded cable.

( ) Connect either end of this shielded cable to the circuit board as follows: Inner lead into hole V (S-1) and the shield lead into hole X (S-1).

( ) Connect the other end of this shielded cable to the circuit board as follows: Inner lead into hole T (S-1) and the shield lead into hole U (S-1).

( ) Prepare the ends of two 7-1/2" red wires as follows:

1. Remove 1/4" of insulation from each end of both wires.
2. Twist together the fine wires at each end of each wire.
3. Melt a small amount of solder on the bare wire ends.

( ) Position one end of each of these two wires even and twist the wires together to form a twisted pair.

( ) At either end of this twisted pair of wires, connect either wire to lug 1 (S-1) and the other wire to lug 2 (S-1) of rocker switch BB. Be sure the bare wire ends do not touch the metal frame of the switch.

( ) Position the twisted pair of wires as shown. At the other end, connect either wire to lug 2 of fuse block CB (S-1) and the other wire to lug 3 of terminal strip CC (NS).

( ) Prepare the end of a 2-1/4" red wire.

( ) Connect this red wire from lug 2 of line cord connector CA (S-1) to lug 2 of terminal strip CC (S-1).

( ) Connect a bare 1/2" wire (remove all the insulation from a length of brown hookup wire) from lug 3 of line cord connector CA (S-1) to lug 1 of fuse block CB (S-1). Bend lug 1 of the fuse block up as shown.

CAUTION: Be sure all wires connect to the fuse block, line cord connector, terminal strip CC, and are at least 1/8" away from the chassis or other metal parts.

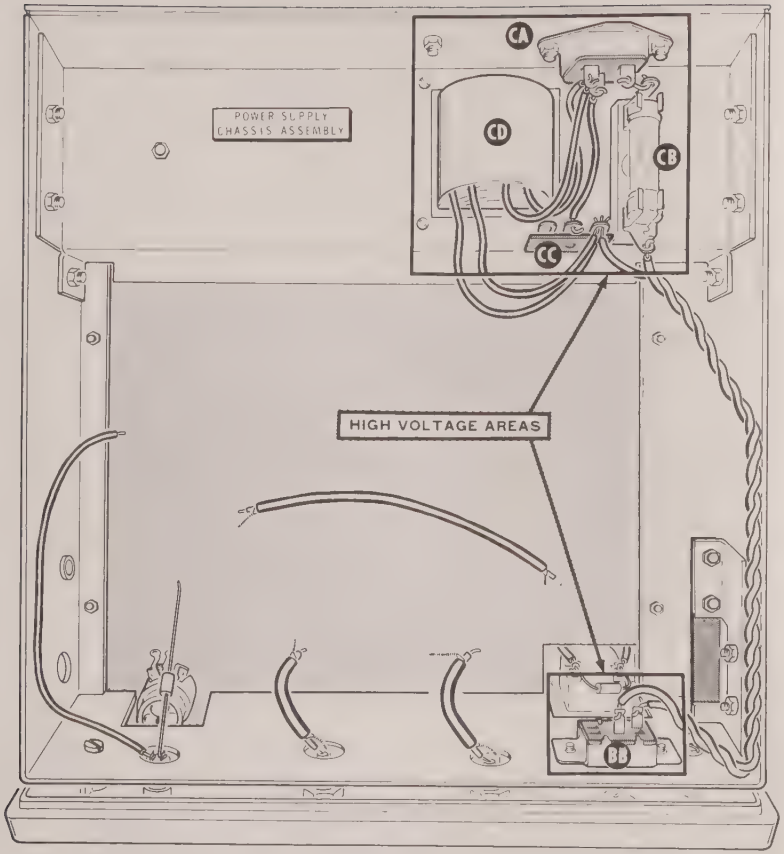


Figure 3

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given below, one for 120 Vac line voltage and the other for 240 Vac line voltage. In the U.S.A. 120 Vac is most often used, while in other countries 240 Vac is more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

120 Vac Wiring

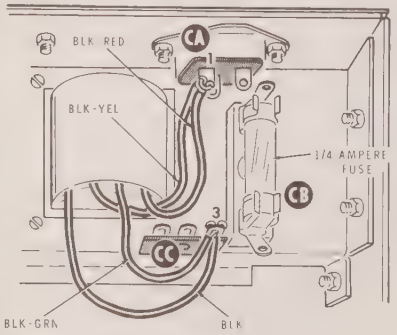
Refer to Detail 13C for the following steps.

Connect the power transformer leads as follows:

( ) Black-red and black-yellow leads to lug 1 of line cord connector CA (S-2).

( ) Black and black-green leads to lug 3 of terminal strip CC (S-3).

( ) Install the 1/4 ampere fuse in fuse block CB.



Detail 13C

This completes the 120 Vac wiring. Proceed to "Wiring Chassis Top."

240 Vac Wiring

Refer to Detail 13D for the following steps.

Connect the power transformer leads as follows:

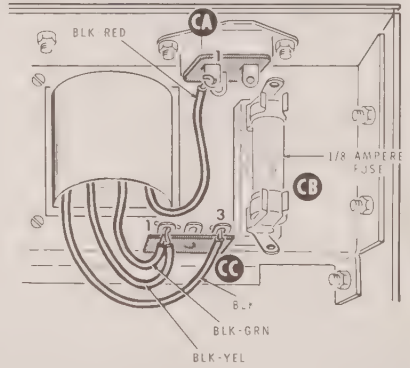
( ) Black-red lead to lug 1 of line cord connector CA (S-1).

( ) Black-green and black-yellow leads to lug 1 of terminal strip CC (S-2).

( ) Black lead to lug 3 of terminal strip CC (S-2).

( ) Install a 1/8 ampere slow-blow fuse (not furnished with the kit) in fuse block CB.

This completes the 240 Vac wiring. Proceed to "Wiring Chassis Top."



Detail 13D

WIRING CHASSIS TOP

Refer to Pictorial 14 (fold-out from Page 20) for the following steps.

( ) Connect the free end of the brown wire coming from hole S in the circuit board to lug 1 of terminal strip AH (NS).

( ) Connect the lamp between lugs 1 (S-2) and 2 (S-1) of terminal strip AH. Position the end of the lamp so it is centered behind the meter. Be sure the leads do not touch each other.

( ) Install the 2500 μF electrolytic capacitor in the capacitor mounting clip at CE. Position the positive (+) end as shown.

( ) Connect the positive (+) lead of this capacitor into hole F of the circuit board (S-1) and the other lead to solder lug CH (S-1). Be sure the positive (+) lead does not touch the metal chassis. Cut off its excess lead lengths.

Connect the leads of the power transformer to the circuit board as follows:

( ) First green into hole A (S-1).

( ) Second green into hole B (S-1).

( ) First red into hole C (S-1).

( ) Second red into hole E (S-1).

( ) Red-yellow to hole D (S-1).

This completes the wiring of the kit. Check to see that all connections are soldered and no solder bridges exist between foils on the circuit board. Shake out any wire clippings or solder splashes. Be sure all excess lead lengths are cut off.

ADJUSTMENTS

Equipment Required:

- A frequency counter that meets the output requirements of the Frequency Scaler (see Specifications on Page 39).
- A signal source capable of producing a signal between 2 and 175 MHz, with an output level between 100 mV and 3 V rms if available.
- A voltmeter capable of measuring 5.25 Vdc, if one is available.

Refer to Figure 2 (fold-out from Page 25) for the following step.

Make the following preset adjustments. Where necessary, use the alignment tool furnished.

( ) OFF-ON – to OFF.

( ) SUPPLY ADJUST – 1/4 turn counterclockwise from its full clockwise position.

( ) BANDWIDTH ADJUST – plates fully closed.

( ) ZERO ADJUST – center of rotation.

( ) 10 division pushbutton – pushed in.

( ) SENSITIVITY – fully clockwise. NOTE: This is a 10 turn control. A slight increase in friction will occur when the control reaches an end limit.

NOTE: If the Frequency Scaler does not perform as described in the following steps, immediately unplug its line cord and refer to the "In Case of Difficulty" section on Page 29.

WARNING: Line voltage is present in the Frequency Scaler as shown by the boxed-in areas in Figure 3 (fold-out from Page 22), when the line cord is plugged into an ac outlet.

NOTE: Do not connect an external signal source (if available) to the INPUT of the Scaler until instructed to do so in a step.

( ) Plug the line cord into the line cord connector on the Frequency Scaler.

( ) Plug the line cord of the Frequency Scaler into an ac outlet of the proper voltage (120 or 240 Vac, depending upon how you wired the power transformer).

( ) Press the OFF-ON switch to ON. The lamp behind the meter should light and the meter might deflect up scale to the right (or read full scale).

( ) If a voltmeter is available, set the SUPPLY ADJUST control so that the voltage at pin 14 of IC1 reads +5.25 Vdc. Then disconnect the voltmeter leads. CAUTION: Do not allow the voltmeter probe to short adjacent pins of an IC together when making the adjustment, as the IC could be permanently damaged.

NOTE: The SENSITIVITY control, to be adjusted in the next step, functions as a peaking adjustment. It is necessary to turn its knob counterclockwise to obtain the highest meter indication. This indicates maximum sensitivity.

( ) Adjust the SENSITIVITY control for a maximum indication on the meter.

( ) Connect the frequency counter to the OUTPUT connection of the Frequency Scaler. Set the frequency counter for 1 to 100 ms gate time or 1 kHz, whichever is appropriate for your counter.

This Note and step only apply if the Scaler is connected to a dc coupled counter.

NOTE: The Frequency Scaler should be adjusted to the counter with which it is to be used. Connecting the Scaler to another dc coupled counter having different input characteristics may require readjustment of the ZERO ADJUST control.

The ZERO ADJUST control, when turned, will cause the frequency counter to start and then stop counting. Observe the small portion of the control's range where this occurs as you adjust the control in the next step. The final setting of the ZERO ADJUST control should be in the center of this small range. Note that the reading on the frequency counter will be unstable.

( ) Set the ZERO ADJUST control as just described.

The adjustment of the BANDWIDTH ADJUST is to provide maximum sensitivity of the Scaler.

( ) Turn the BANDWIDTH ADJUST clockwise until the counter just stops counting. You should now have a minimum indication on the meter of the Frequency Scaler. See the inset drawing in Figure 2.

( ) Rotate the SENSITIVITY control back-and-forth to see if the counter will again start to count. If it does, repeak the SENSITIVITY control, and then readjust the BANDWIDTH ADJUST until the counter stops counting.

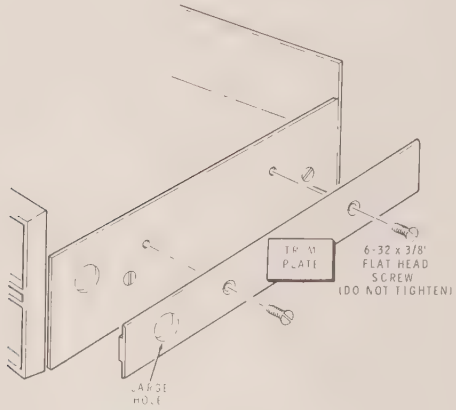
( ) Repeat the above step as many times as necessary. When further adjustment of the SENSITIVITY control will no longer start the counter counting, the adjustment is completed. Do not turn the BANDWIDTH ADJUST any further clockwise than necessary. Otherwise input sensitivity will be lost.

( ) If available, connect a signal source (between 2 MHz and 175 MHz) to the INPUT of the Frequency Scaler. A correct frequency reading should be obtained on the frequency counter.

( ) Depress the divide-by-100 pushbutton. The frequency counter should now read at the new division ratio. A slight peaking of the SENSITIVITY control may be necessary.

This completes the Adjustments. Disconnect all the equipment and the line cord from the Frequency Scaler. Then proceed to "Final Assembly."

FINAL ASSEMBLY

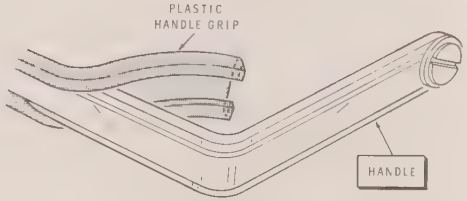


Detail 15A

Refer to Pictorial 15 (fold-out from Page 27) for the following steps.

( ) Refer to Detail 15A and loosely mount a trim plate on each side of the main chassis with 6-32 x 3/8" flat head screws. Align the large hole in each trim plate with the large hole in the main chassis.

( ) Refer to Detail 15B and install the handle grip on the handle.



Detail 15B

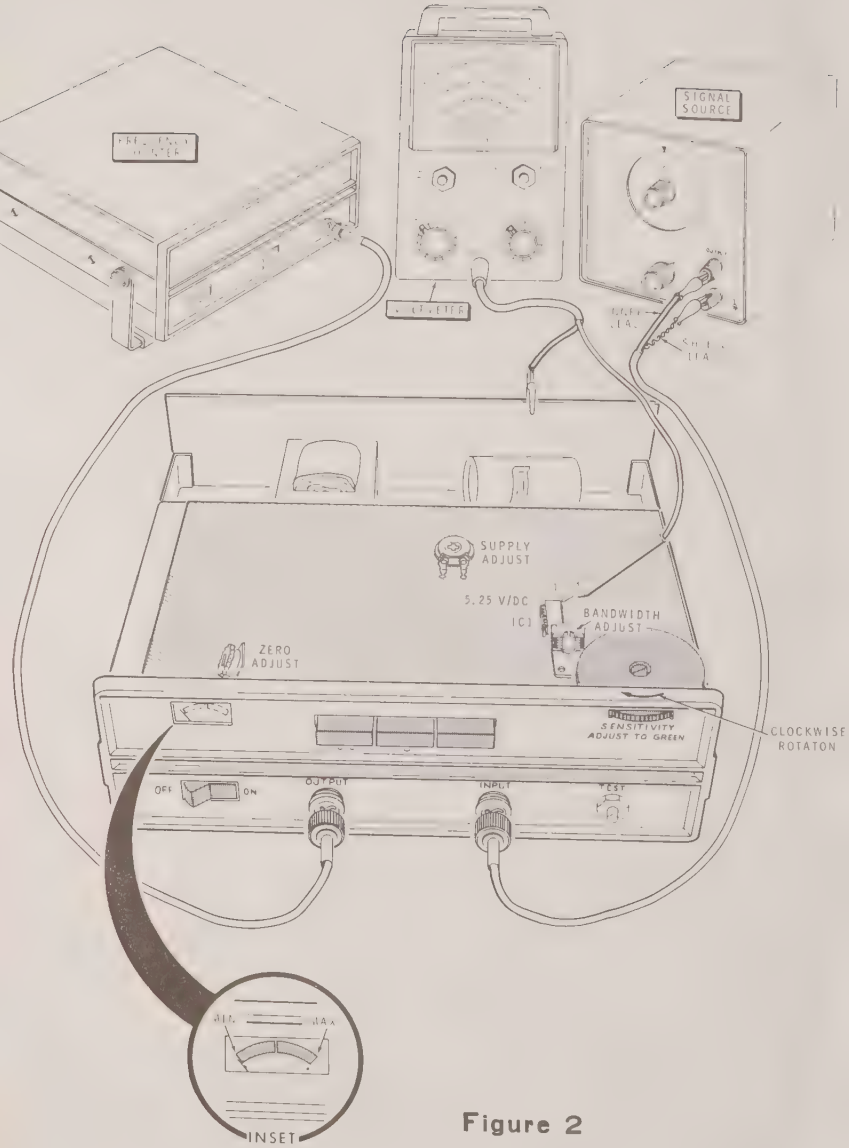
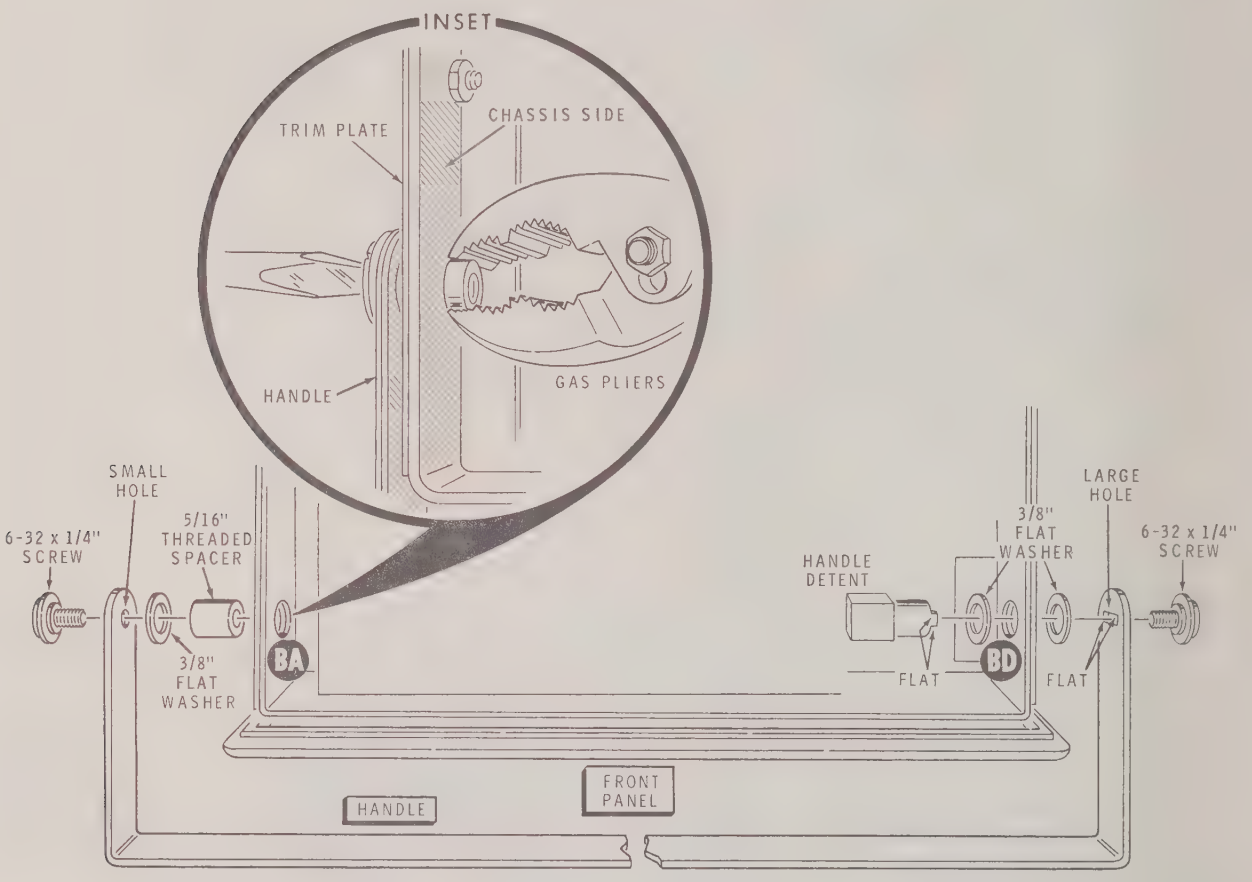


Figure 2


INSET
TRIM PLATE
CHASSIS SIDE
HANDLE
GAS PLIERS
SMALL HOLE
6-32 x 1/4" SCREW
5/16" THREADED SPACER
3/8" FLAT WASHER
BA
HANDLE
FRONT PANEL
HANDLE DETENT
FLAT
BD
3/8" FLAT WASHER
LARGE HOLE
FLAT
6-32 x 1/4" SCREW

Detail 15C

Refer to Detail 15C for the following steps.

( ) Position the handle so the end with the round hole is aligned with hole BA in the trim plate and the chassis side.

( ) At BA, install the 6-32 threaded spacer with a 3/8" flat washer and a 6-32 x 1/4" screw. See the inset drawing in Detail 15C. Use gas pliers to keep the threaded spacer from turning.

( ) Install the handle detent at BD with two 3/8" flat washers and a 6-32 x 1/4" screw. Be sure the flat on the handle detent is aligned with the slotted hole in the handle. NOTE: One of the flat washers must be positioned between the inside of the chassis and the flat spring before the handle detent can be inserted into hole BD.

Refer to Pictorial 15 for the following steps.

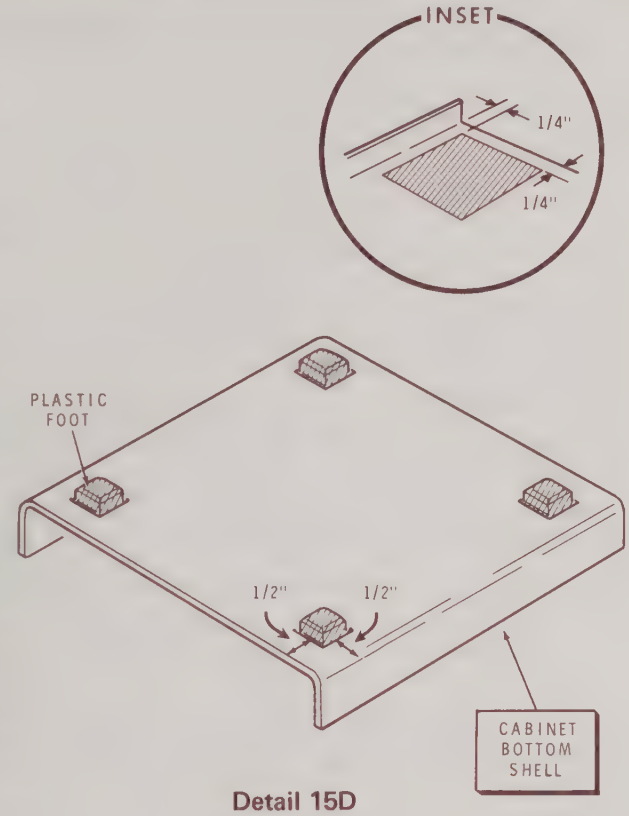
( ) Refer to Detail 15D, remove the protective backing from the four feet, and install them on either cabinet shell. This is now the cabinet bottom shell.

( ) Remove the protective backing from the fish paper insulator. Press this insulator in place on the inside of the cabinet bottom shell according to the dimensions in the inset drawing in Detail 15D.

( ) Position the chassis onto the bottom cabinet shell, and position the other cabinet shell onto the top of the chassis. Be sure the fish paper insulator is positioned under the power transformer. The side edges of each cabinet shell must fit between the chassis and trim plates.

( ) Tighten the screws in both trim plates to hold the cabinet shells in place.

NOTE: The blue and white label that will be installed in the next step, shows the model number and production series number of your kit. Refer to these numbers in any communications with the Heath Company. This assures you that you will receive the most complete and up-to-date information in return.



Detail 15D

( ) Carefully peel the backing paper from the blue and white identification label. Press the label onto the rear panel as shown in the inset drawing on Pictorial 15.

This completes the Final Assembly. Proceed to the "Operation" section on Page 28.

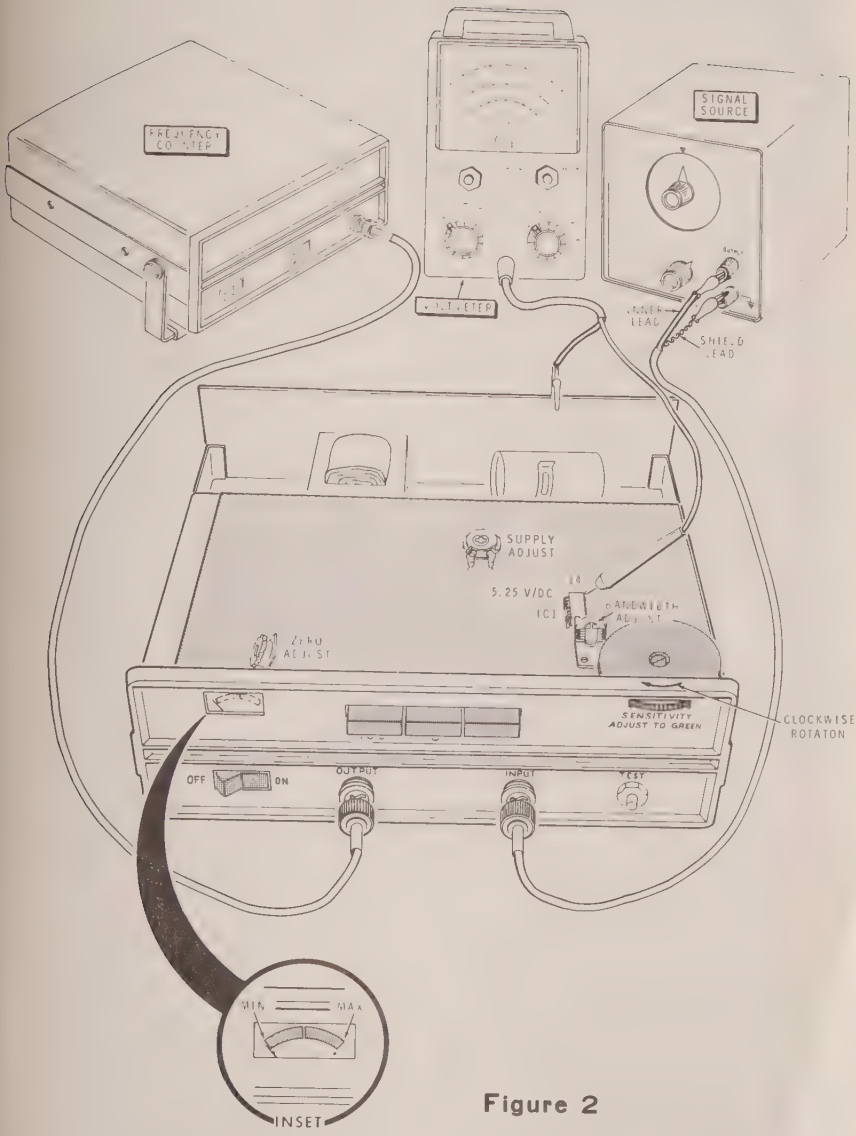

FREQUENCY COUNTER
SIGNAL SOURCE
SHIELD LEAD
SUPPLY ADJUST
5.25 V/DC
IC1
BANDWIDTH ADJUST
ZERO ADJUST
SENSITIVITY ADJUST TO GREEN
CLOCKWISE ROTATON
OFF
ON
OUTPUT
INPUT
TEST
MIN
MAX
INSET

Figure 2

IN CASE OF DIFFICULTY

This section of the Manual is divided into five parts. "Visual Tests," "Precautions for Troubleshooting," "Power Supply and Meter Tests," "Logic Circuit Tests," and "Checking Transistors." Begin your search for any trouble that occurs after assembly by carefully following the checks listed in the "Visual Test" section.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the Service and Warranty section of the "Kit Builders Guide." Refer also to "Factory Repair Service" information on Page 38 if it becomes necessary to return your kit for factory repair.

Refer to the "Circuit Board X-Ray View" on Page 47 and the "Chassis Photos" on Page 44 for the physical location of parts on the circuit board and chassis.

VISUAL TESTS

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the kit builder.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the "Soldering" section of the "Kit Builders Guide."

3. Check to be sure all transistors are in their proper locations. Make sure each lead is connected to the proper point.

4. Check to be sure that all of the IC pins are properly installed in their connectors and not bent out or under the IC. Also be sure the IC's are installed in their correct positions.

5. Check the values of the parts. Be sure in each step that the proper part has been wired into the circuit, as shown in the Pictorial diagrams. It would be easy, for example, to install a 10 Ω (brown-black-black) resistor where a 100 Ω (brown-black-brown) resistor should have been installed.

6. Check each electrolytic and tantalum capacitor to make sure the positive-marked end is positioned properly. Check each diode to be sure the banded end is positioned properly.

7. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

8. A review of the Circuit Description may also help you determine where the trouble is.

If the trouble is still not located after the vi al tests are completed, and a voltmeter is available, check voltage readings against those shown on the "Voltage Chart" (on Page 46). Read the "Precautions for Troubleshooting" before making any measurements. NOTE: All voltage readings were taken with a high impedance voltmeter. Voltages may vary as much as ±20%.

PRECAUTIONS FOR TROUBLESHOOTING

1. Be cautious when testing IC and transistor circuits. Although they have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than tubes.

2. Be sure you do not short any terminals to ground when making voltage measurements. If the probe should slip, for example, and short out a bias or supply point, it is very likely to cause damage to one or more IC's, transistors, or diodes.

Power Supply and Meter Tests

The following chart lists some conditions and possible causes of malfunctions in the power transformer wiring, the circuits of the power supplies, and the meter. If a particular part or parts are mentioned (transistor Q5 or resistor R23, for example) as a possible cause, check these parts to be sure they are correctly installed or wired correctly. Also check to see if an improper part was installed at that location. It is also possible, on rare occasions, for a part to be faulty.

TROUBLESHOOTING CHART #1

CONDITION	POSSIBLE CAUSE
A. Pilot lamp does not light.	1. Line cord not plugged in. 2. Fuse. 3. Pilot lamp. 4. Transistor Q6 or Q7. 5. Diodes D7, D8, ZD1, or ZD2. 6. Resistor R22 or R23. 7. Capacitors C21, C22, or C23.
B. No +5 voltage source.	1. See condition A, causes 4, 5, 6, and 7.
C. The +5 voltage source too high or too low.	1. Zener diode ZD1 or ZD2.
D No -5 voltage source.	1. See condition A, causes 4, 5, 6, and 7.
E. The -5 voltage source too high or too low.	1. Zener diode ZD1 or ZD2.
F. No +5.2 voltage source	1. Diodes D3, D4, D5, and D6. 2. Transistors Q4, Q5, and associated parts. 3. IC8 and associated parts.
G. The +5.2 voltage source too high or too low.	1. Improper setting of Supply Adjust control R31. 2. Zener diode ZD3.
H. Meter does not deflect.	1. Shielded cable from holes Y and X to holes T and U. 2. Diode D1 or D2. 3. Resistors R9. 4. Capacitors C9, C11, or C12. 5. Meter. 6. Insufficient input signal.

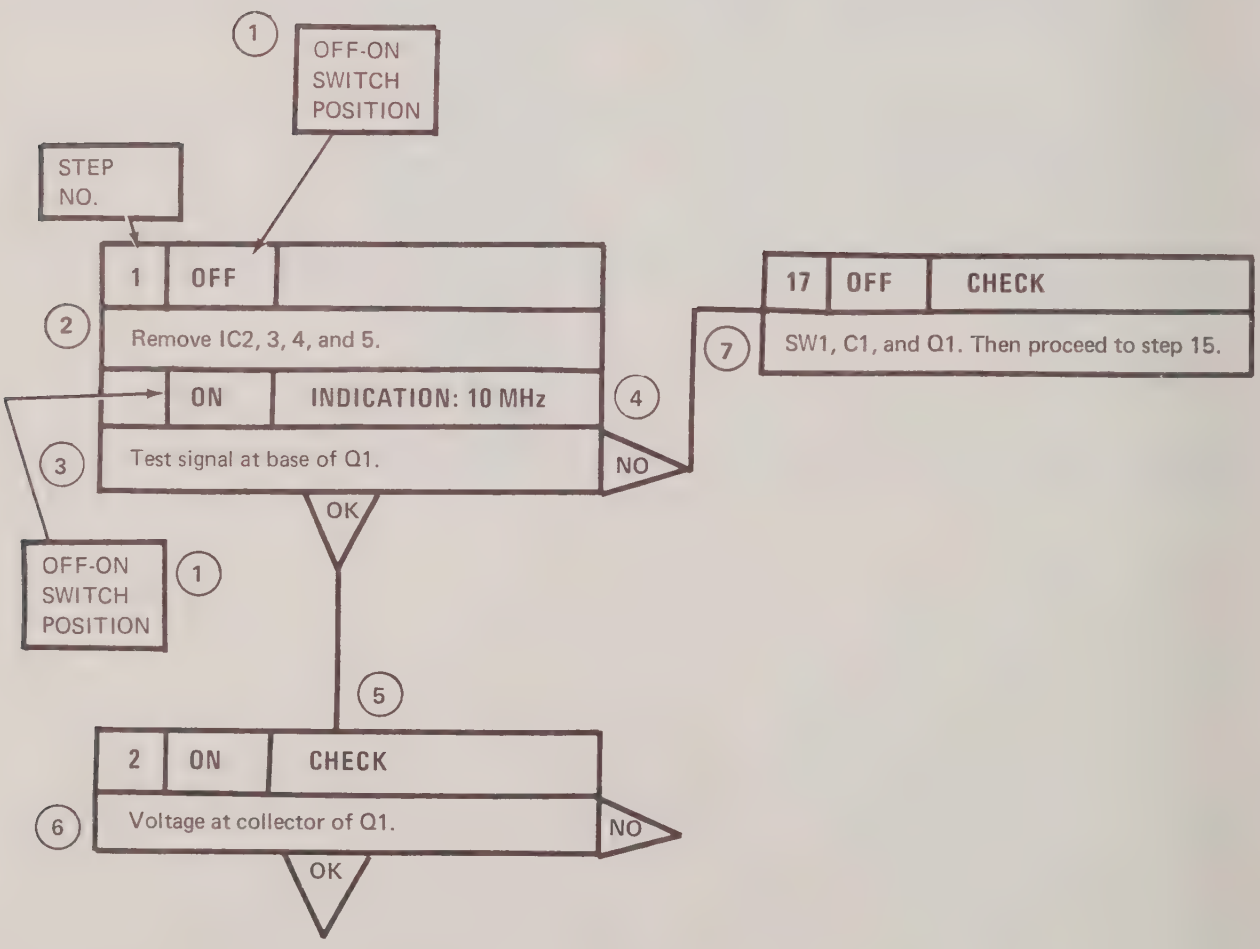
Logic Circuit Tests

If the Frequency Scaler does not divide properly and you have determined that the power supply voltages are correct, it will be necessary to test the logic circuits. This is done by following "Troubleshooting Chart #2," in which you will feed a signal of known frequency into the input of the Frequency Scaler and check the frequency of this signal at various points in the circuit with a frequency counter. In this chart, a step-by-step technique of frequency and voltage tests will enable you to locate the problem area in the circuit. This could be the result of a poor solder connection, the installation of a wrong value part, an incorrectly wired part or, on a rare occasion, a faulty part.

Begin the testing at "Start" on "Troubleshooting Chart #2." As a step is performed you will get an OK or NO result, which steers you to the next step. These steps will quickly bring you to a point where you are instructed to check a particular component. Check the component, for proper installation. Replace the component if it is faulty.

After a repair has been made, check the Frequency Scaler for proper operation, or follow the instructions in the step on the Chart where the fault first showed up. If the kit still does not perform properly, return to "Start" on the Chart and begin the tests again. Possibly there is more than one problem that must be corrected.

Sample Test Chart
(Not to be used for any tests)



USING TROUBLESHOOTING CHART #2

Learn how to use "Troubleshooting Chart #2" properly by referring to the "Sample Test Chart" and reading through the following paragraphs. Do not actually perform the steps. The numbers on the paragraphs are keyed to the circled numbers on the "Sample Test Chart."

1. Turn the Frequency Scaler OFF or ON, as instructed here, with the OFF-ON switch. WARNING: Always turn the Frequency Scaler OFF when removing or installing IC's. When removing or installing any other component, always unplug the line cord of the Frequency Scaler, as line voltage is present at a number of points in the chassis as shown by the boxed-in areas in Figure 3.

2. Follow the instructions given here before you perform the test.

3. This is the test point in the Frequency Scaler from which the signal is taken. NOTE: All "Test signal" measurements are taken with a .01 μF capacitor connected in series with the inner lead of the cable from the frequency counter. The free lead of this capacitor is then touched to the location called out in the step. Remove this capacitor when checking the signal at the Output of the Frequency Scaler and connect the cable directly to the Output connector.

4. This is the frequency that should be read on the frequency counter.

5. This denotes that a check of a voltage or components are to be made.

6. When checking a voltage, as indicated, use the "Voltage Chart" on "Troubleshooting Chart #2." All voltages were taken with a high impedance input voltmeter. Voltages can vary ±20%.

7. These parts should be checked to see that the proper part is installed properly according to the "Step-by-Step Assembly" instructions, that their solder connections are good, and that no solder bridges exist between the foils connected to the part and an adjacent foil. If everything appears alright, the part can be checked electrically. If a part is faulty, it must be replaced with an identical replacement part.

Proceed to "Start" on "Troubleshooting Chart #2" and perform the steps. NOTE: an input signal of 10 MHz is used to make frequency comparison checks. If a different input frequency is used, all other frequencies must be changed accordingly in "Troubleshooting Chart #2." Be sure to take into consideration the limitations of your frequency counter if you select another input frequency.

TROUBLESHOOTING CHART #2

START

1 OFF
Remove IC2, IC3, IC4, and IC5.
ON — INDICATION: 10 MHz
Feed 10 MHz signal to INPUT connector. Depress divide-by-10 pushbutton. Test signal at base of Q1.
NO → **17** OFF — CHECK: SW1, C1, and Q1. Then proceed to step 15.
OK ↓

2 ON — INDICATION: 10 MHz
Test signal at collector of Q1.
NO → **18** OFF — CHECK: Q1. Then proceed to step 15.
OK ↓

3 ON — INDICATION: 10 MHz
Test signal at pin 6 of IC1
NO → **19** ON — CHECK: Voltages at IC1. If wrong, replace IC1. Then proceed to step 15.
OK ↓

4 OFF
Reinstall IC2.
ON — INDICATION: 5 MHz
Test signal at pin 3 of IC2.
NO → **20** ON — CHECK: Voltages at IC2. If wrong, replace IC2. Then proceed to step 15.
OK ↓

5 OFF
Reinstall IC3.
ON — INDICATION: 2.5 MHz
Test signal at pin 1 of IC3.
NO → **21** ON — CHECK: Voltages at IC3. If wrong, replace IC3. Then proceed to step 15.
OK ↓

6 OFF
Reinstall IC4
ON — INDICATION: 1.25 MHz
Test signal at pin 1 of IC4.
NO → **22** ON — CHECK: Voltages at IC4. If wrong, replace IC4. Then proceed to step 15.
OK ↓

7 OFF
Remove IC3 and IC4. Reinstall IC5.
ON — INDICATION: 2.5 MHz
Test signal at pin 1 of IC5.
NO → **23** ON — CHECK: Voltages at IC5. If wrong, replace IC5. Then proceed to step 15.
OK ↓

Proceed to step 8.

8 OFF
Reinstall IC3 and IC4.
ON — INDICATION: 1 MHz
Test signal at pin 1 of IC5
NO → **24** OFF
Remove IC4
ON — INDICATION: 1.666 MHz
Test signal at pin 1 of IC5
NO → **38** OFF
Interchange IC3 and IC5 in their sockets.
ON — INDICATION: 2.5 MHz
[illegible]
NO → **44** OFF
Replace faulty IC5. Then proceed to step 15.
OK ↓

39 OFF
Replace faulty IC3. Then proceed to step 15
OK ↓

25 OFF
Reinstall IC4 and perform step 9.
OK ↓

9 ON — INDICATION: 1 MHz
Test signal at base of Q2
NO → **26** OFF — CHECK: Q2 and C14. Then proceed to step 15.
OK ↓

10 OFF
Remove IC6
ON — INDICATION: 1 MHz
Test signal at collector of Q2.
NO → **27** ON — CHECK: Voltages at Q2.
OFF — CHECK: Q2. Then proceed to step 15.
OK ↓

Proceed to step 11.

TROUBLESHOOTING CHART #2 (Cont'd.)

11 OFF
Reinstall IC6 and remove IC7.
ON — INDICATION: 1 MHz
Test signal at pin 13 of IC6.
NO → **28** OFF: Replace faulty IC6. Then proceed to step 15.
OK

12 ON — INDICATION: 1 MHz
Test signal at pin 11 of IC6.
NO → **29** ON — CHECK: Voltage at pin 12 of IC6 should be 4 V minimum.
NO → **40** OFF — CHECK: R14 and pins 5 and 6 of SW2. Then proceed to step 15.
OK → **30** OFF: Perform step 28.
OK

13 ON — INDICATION: 1 MHz
Test signal at pin 6 of IC6.
NO → **31** ON — CHECK: Voltage at pin 4 of IC6 should be 4 V minimum.
NO → **41** ON — CHECK: Voltage at pin 2 of IC6. Should be 0 V
NO → **45** OFF — CHECK: Jumper wire between pin 3 of SW2 and pin 3 of SW3. Then proceed to step 15.
OK → **32** OFF: Perform step 28.
OK → **42** OFF: Perform step 28.
OK

14 ON — INDICATION: 1 MHz
Test signal at gate (G) of Q3.
NO → **33** OFF — CHECK: Q3 and C17. Then proceed to step 15.
NO → **34** — CHECK: Setting of Zero Adjust control (see adjustments) or Q3. Then repeat step 15.
OK

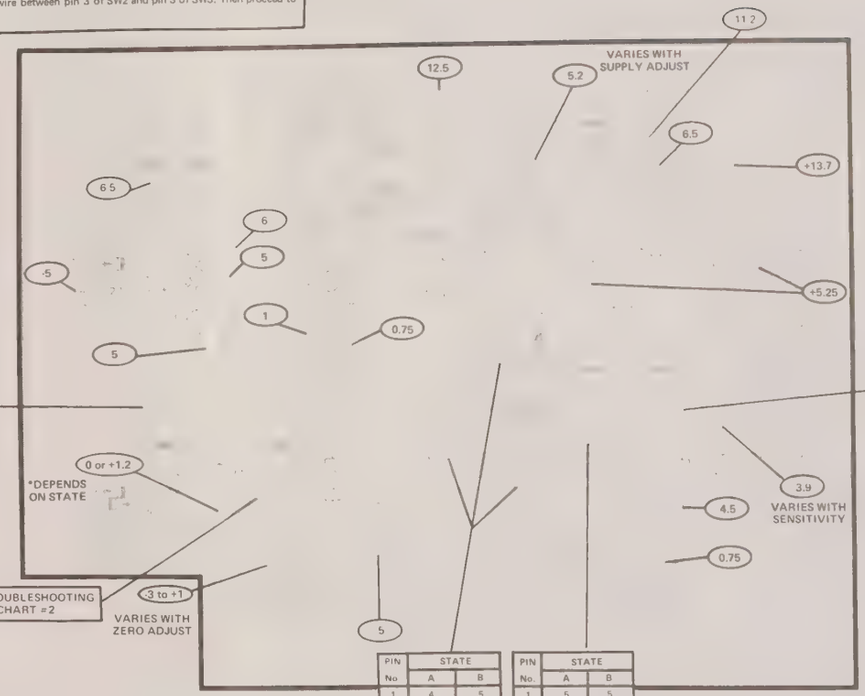
15 OFF
Reinstall any removed IC's except IC7. Remove IC7 if it is still in its socket.
ON — INDICATION: 1 MHz
Test (direct-coupled) signal at Output.
NO
OK

NOTE: The divide-by-10 function is operating properly. Proceed as follows and check the divide-by-100 function.

16 OFF
Reinstall IC7 and depress the divide-by-100 pushbutton.
ON — INDICATION: 100 kHz
Test (direct-coupled) signal at Output.
NO → **35** ON — INDICATION: 500 kHz: Test signal at pin 12 of IC7.
NO → **36** ON — INDICATION: 100 kHz: Test signal at pin 11 of IC7.
NO → **43** OFF: Replace faulty IC7. Then repeat step 16.
OK
OK → **37** — CHECK: Setting of Zero Adjust control (see Adjustments), Q3, or IC6. Then repeat step 16.
OK

NOTE: The divide-by-100 function is operating properly. Recheck the Adjustments. This completes the tests.

PIN No.	STATE A	STATE B
1	0.4 MAX	0.4 MAX
2	0	0
3	0	0
4	—	—
5	4	5
6	0	0
7	0	0
8	—	—
9	—	—
10	0	0
11	2.4 to 4	2.4 to 4
12	2.4 to 4	0.4
13	—	—
14	0.4	2.4 to 4



PIN No.	STATE A	STATE B
1	4	5
2	4	5
3	4	5
4	4	5
5	4	5
6	5	4
7	0	0
8	5	4
9	4.5	4.5
10	4.5	4.5
11	4.5	4.5
12	4	5
13	—	—
14	4	5

PIN No.	STATE A	STATE B
1	4	5
2	0	0
3	4.5	4.5
4	0	0
5	4.5	4.5
6	4.5	4.5
7	0	0
8	0	0
9	0	0
10	0	0
11	4.5	4.5
12	0	0
13	5	4
14	5	5

PIN No.	STATE A	STATE B
1	5	5
2	5	4
3	4	5
4	—	—
5	—	—
6	0	0
7	0	0
8	4.5	4.5
9	—	—
10	4	5
11	4	5
12	5	4
13	—	—
14	5	5

VOLTAGE CHART
(VIEWED FROM SCREEN SIDE)

NOTES:

1. All voltages are dc and taken with a high impedance voltmeter from the point indicated to chassis ground. Voltages may vary ±20%.
2.* IC voltages have an A and B state of logic.
   A. Sensitivity control adjusted to 3.5 V at pin 9 of IC1.
   B. Sensitivity control adjusted to 4.5 V at pin 9 of IC1.

NOTE: 4-5 means this voltage can be either 4 volts or 5 volts.

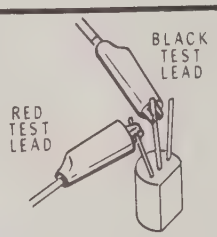
Checking Transistors

NOTE: The internal wiring of most ohmmeters is such that the positive terminal of the ohmmeter battery is connected to the positive (red) test lead, and the negative battery terminal is connected to the negative (black) test lead. In some ohmmeters, this wiring is reversed and erroneous readings will be obtained when making the following measurements. Try reversing the ohmmeter test leads if the measurements do not check correctly the first time.

Transistors may be checked as follows:

1. Remove the transistor from the circuit board.
2. Set the ohmmeter range switch to RX1000.
3. Connect the ohmmeter leads to the transistor leads as shown in the example below.

EXAMPLE

Connect the red test lead to one lead as directed in the Checkout Chart.	
Connect the black test lead to another lead, as directed in the Checkout Chart.	

NOTE: The base diagrams are viewed from the bottom of the transistor.

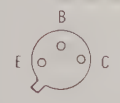
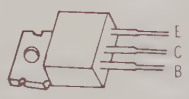
TRANSISTOR	FET
B = BASE	G = GATE
C = COLLECTOR	S = SOURCE
E = EMITTER	D = DRAIN
	C = CASE

CHECKOUT CHART

Meter Range: x 1000

NOTE: If the meter reading indicates that a transistor is faulty, recheck the reading before replacing the transistor.

*NOTE: The meter readings can vary ±20%.

TYPE	HEATH PART NO.	BASE DIAGRAM	CONNECT METER + LEAD TO TRANSISTOR LEAD:	CONNECT METER - LEAD TO TRANSISTOR LEAD	METER READING * RANGE X 1000
2N3393	417-118		B B E E C	C E C B B	8500 9000 INF INF INF
2N2369	417-154		B B E E C	C E C B B	9500 8000 INF INF INF
TA2911	417-175		B B E E C	C E C B B	5000 5000 INF INF INF
TIS87	417-258		B B E E C	C E C B B	10,000 10,000 10,000 INF INF
UC734	417-167		S D G S D G	D S S G G D	2500 2500 10,000 INF INF 10,000

FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) Or, if you wish, you can deliver your kit to a nearby Heathkit Electronic Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heathkit Electronic Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you send the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heathkit Electronic Center, please ship it to the factory at Benton Harbor, Michigan and observe the following shipping instructions:

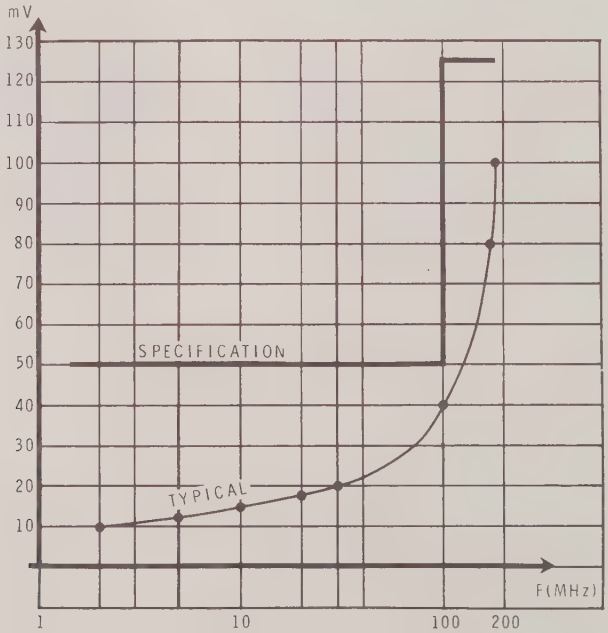
Prepare a letter in duplicate, containing the following information:

- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan 49022.

Check the equipment to see that all parts and screws are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022



SENSITIVITY VERSUS FREQUENCY CHART

SPECIFICATIONS

Frequency Range	2 MHz to 175 MHz.
Resolution (Counter with 1 ms time base)	Divide by 10 = 10 kHz. Divide by 100 = 100 kHz.
(Counter with 1 s time base)	Divide by 10 = 10 Hz. Divide by 100 = 100 Hz.
Meter	Green area indicates adequate signal level.

INPUT

Sensitivity*	50 mV: 2 MHz to 100 MHz. 125 mV: 100 MHz to 175 MHz.
Impedance	Divide by 1: Same as frequency counter. Divide by 10 and 100: 50 Ω.
Amplitude (maximum)	3 V rms, in ÷ 10 and ÷ 100 and 600 V rms, in ÷ 1.

OUTPUT

Amplitude (minimum)	1 V across 1 MΩ and 20 pF load.
Rise Time	20 ns.
Fall Time	10 ns.
Offset From Ground	Adjustable from zero to ±500 mV.

GENERAL

Power Requirements	110 - 130 or 220 - 260 Vac, 50/60 Hz, 5 watts.
Ambient Temperature Range	Storage: -55 degrees C to 80 degrees C. Operation: 10 degrees C to 40 degrees C.
Dimensions	8-1/4" wide x 3-3/8" high x 9" deep. (Dimensions do not include handle.)
Weight	7 lbs.

*See Sensitivity-Versus-Frequency Chart on Page 38.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

Refer to the Block Diagram (Page 41) and the Schematic Diagram (fold-out from Page 47) while you read this "Circuit Description."

GENERAL

Input transistor Q1 isolates the input from trigger circuit IC1 and amplifies the input signal. IC1 consists of two OR gates that shape the signal into pulses and change the reference level of these pulses from ground to a positive level. The divide-by-2 circuit, IC2, and the divide-by-5 circuits, IC3, IC4, and IC5, work together to divide the total number of input pulses by ten. These divided pulses are then fed to level translator Q2 where their positive level is changed back to the near-zero or ground reference required for the following circuits. From the collector of Q2, the pulses are applied to the gating circuits of IC6 and the divide-by-10 circuit IC7.

The divide-by-10 and the divide-by-100 switches turn on the proper gates in IC6. When the divide-by-10 switch is depressed, the pulses from Q2 are applied through the gating circuits of IC6, buffer transistor Q3, to the Output terminals. When the divide-by-100 switch is depressed, the pulses from Q2 are first divided by ten in IC7, and then applied through Q3 to the Output terminals.

NOTE: Portions of some of the IC's in this Scaler are not used or required.

INPUT CIRCUIT

Input amplifier transistor Q1 offers a 50 Ω input impedance to the applied signal. This stage also provides isolation between the input and the trigger circuit that follows.

TRIGGER CIRCUIT

Trigger circuit IC1 consists of two OR gates that are connected to provide two functions: They use a positive and negative limiting action to shape the input signal into square-wave pulses that are suitable for driving the logic circuits that follow, and they shift the reference level of these pulses to a positive dc that provides correct bias to the following circuits. Figure 5 shows the relationship between the input signal and the output pulses of these two gates.

Sensitivity control R7, which is connected in a voltage divider with R5 and R8, provides bias to the first gate. This control is adjusted for optimum output at high frequencies.

Pressing the Test switch places a small amount of power supply ripple across resistor R5 to provide a test signal to the two OR gates. This test signal is then added to the input signal. If the addition of this small (approximately 5 mv) test signal causes the OR gates to trigger irregularly (unstable triggering), either the input signal is too weak or the Sensitivity control requires adjustment. Trimmer capacitor C8 provides a small amount of negative feedback to the first OR gate to improve the bandwidth.

DIVIDE-BY-2

Divide-by-2 circuit IC2 contains a D-type repeater flip-flop that changes states only when a positive-going pulse (the leading edge of a square wave) is applied to input C2. Figure 6 shows the relationship between the input and output pulses of IC2. Notice that two complete pulses are required to produce one pulse in the output, hence, the number of input pulses is divided by two.

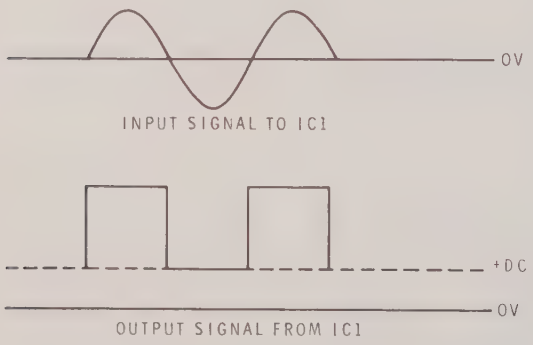


Figure 5

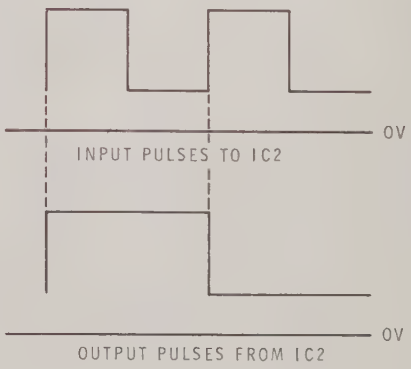
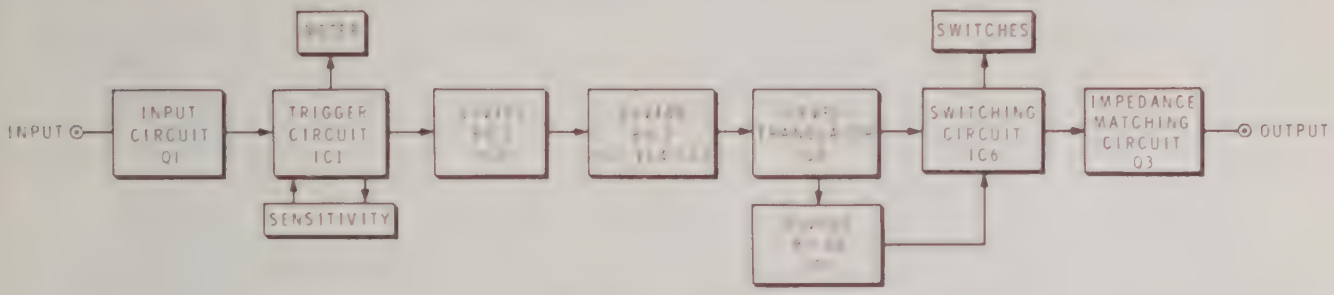


Figure 6



BLOCK DIAGRAM

DIVIDE-BY-5

IC3, IC4, and IC5 make up the divide-by-5 circuit. Each of these three integrated circuits contains a single J-K flip-flop. Various feedback connections are made between these IC's to provide only one pulse out to the level translator for every five pulses received from the divide-by-2 circuit.

The combined effect of the divide-by-2 and the divide-by-5 circuits will be to divide the number of pulses supplied from the trigger circuit by 10. For example: For every 100 pulses received from the trigger circuit, the divide-by-2 circuit provides only 50 pulses to the divide-by-5 circuit. For every 50 pulses received from the divide-by-2 circuit, the divide-by-5 circuits provide only 10 pulses to the level translator.

LEVEL TRANSLATOR

Level translator transistor Q2 amplifies the pulses received from the divide-by-5 circuit and shifts the reference level of these pulses to the near-zero or ground reference required by the following circuits. These pulses are connected to pin 13 of IC6 and pin 14 of IC7.

GATING CIRCUIT

Gating circuit IC6 uses three of the four NAND gates contained within its module. These three gates are controlled by two of the pushbutton switches located on the front panel of the Scaler. The selection of the divide-by-1 function routes the input signal straight through the switches to the Output of the Scaler. The selection of the divide-by-10 function connects a +5 volts through SW2 to pin 12 of the first gate. Since the two input levels to the first gate are the same (+), the gate is opened, allowing inverted (-) pulses to be applied to pin 5 of the second gate. At the same time a (+) level is applied to pin 4, opening the second gate and allowing the divided-by-10 pulses to be routed from pin 6, through buffer Q3, to the Output.

Selection of the divide-by-100 function closes the first gate of IC6. A +5 volts is applied through SW3 to pin 2 of the third gate, opening this gate to pulses received from pin 11 of decade counter IC7. Inverted (-) pulses are then fed from pin 3 of the third gate to pin 4 of the second gate. At the same time a +5 volts is applied to pin 5, opening the second gate and allowing the divided-by-100 pulses to be routed from pin 6, through buffer Q3, to the Output.

DIVIDE-BY-10

Divide-by-10 circuit IC7 is a decade counter. This circuit uses one gate and four J-K flip-flops connected in such a way as to divide by 10. This process of further dividing the received pulses by ten has the overall effect of dividing by 100. For example: For every 100 pulses received from the trigger circuit, ten pulses are routed to the divide-by-10 circuit. Then, for every 10 pulses received by this circuit, only 1 pulse is routed through the gating circuit and buffer transistor Q3 to the Output, hence, the number of pulses from the trigger circuit is divided by 100.

BUFFER

Buffer transistor Q3 is a field-effect transistor with an input impedance large enough to keep the IC's from being loaded by the output. The output impedance of Q3 is small enough to provide a matched impedance with the coaxial cable connected to the output circuit.

METER

The meter obtains its signal from the trigger circuit. Since the trigger circuit already limits the amplitude of its output signal to IC2 (the process used to shape the input signal into a square wave), this feature is also used to prevent possible pegging of the meter needle. The coaxial cable used to connect the meter with the trigger circuit exhibits an internal capacitance at high frequencies. This internal

capacitance is effectively neutralized by the coil etched on the circuit board foil. Diodes D1 and D2 detect the amplitude level of the signal received from the trigger circuit. This amplitude level is then filtered and applied to the meter to present a visual indication of adequate signal strength for proper operation of the circuits.

POWER SUPPLY

Dual-primary transformer T1 can be wired to operate from either 120 Vac or 240 Vac. Two secondary output windings furnish the ac voltage for the +5.25-volt, +5-volt, and -5-volt power supplies.

+5.25-Volt Power Supply

Diodes D3, D4, D5, and D6 form a rectifier bridge network for the +5.25 voltage. The rectified output voltage from this bridge is filtered by R21 and C24, and then applied to the collectors of pass transistors Q4 and Q5.

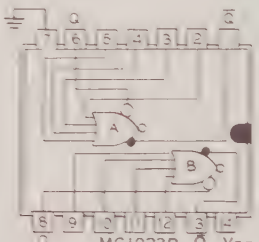
Transistor Q5 acts as a variable resistor to keep the +5.25 voltage constant by continuously comparing it to a reference voltage furnished to Q4 by operational amplifier IC8. IC8 measures any difference between the reference voltage obtained from the wiper of Supply Adjust control R31 and the actual output voltage at the emitter of Q5. Any difference between the reference voltage and the actual output voltage is amplified and used to control Q4, which drives Q5 to keep the +5.25-volt supply constant.

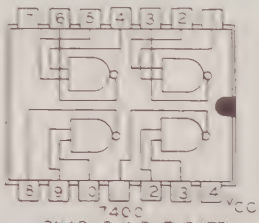
+5-and -5-Volt Power Supply

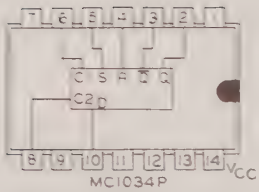
The +5-volt and the -5-volt sources are obtained from a separate power supply to keep them from being affected by stray signals. Stray signals, if carried within the voltage source, could cause the logic circuits to trigger at random and produce errors in the output.

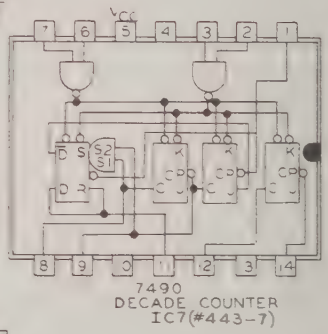
Diodes D7 and D8 form a full-wave rectifier for the +5-volt and the -5-volt regulator. Constant-current amplifier transistors Q6 and Q7 maintain a constant current to zener diodes ZD1 and ZD2, the +5-volt and -5-volt loads. Any increase in dc voltage into the regulator would result in an increase in current through R22. This would increase the forward bias on Q6 and result in more current through R23. An increase in current through R23 would decrease the forward bias on Q7 and result in less current through R22, thus returning Q6 to normal.

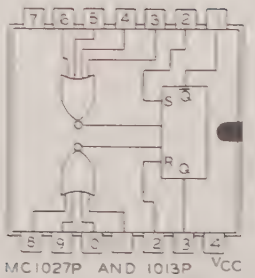
INTEGRATED CIRCUITS

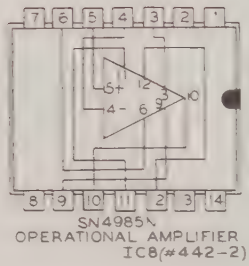




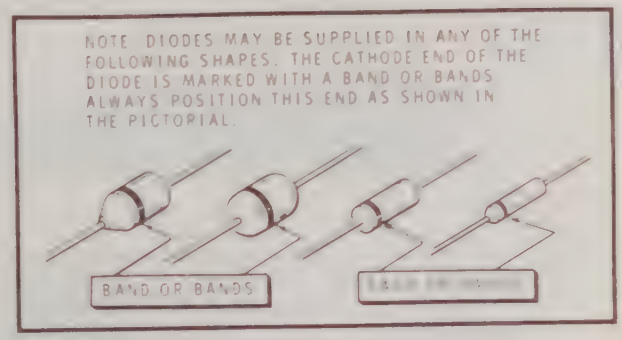
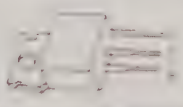
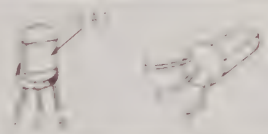






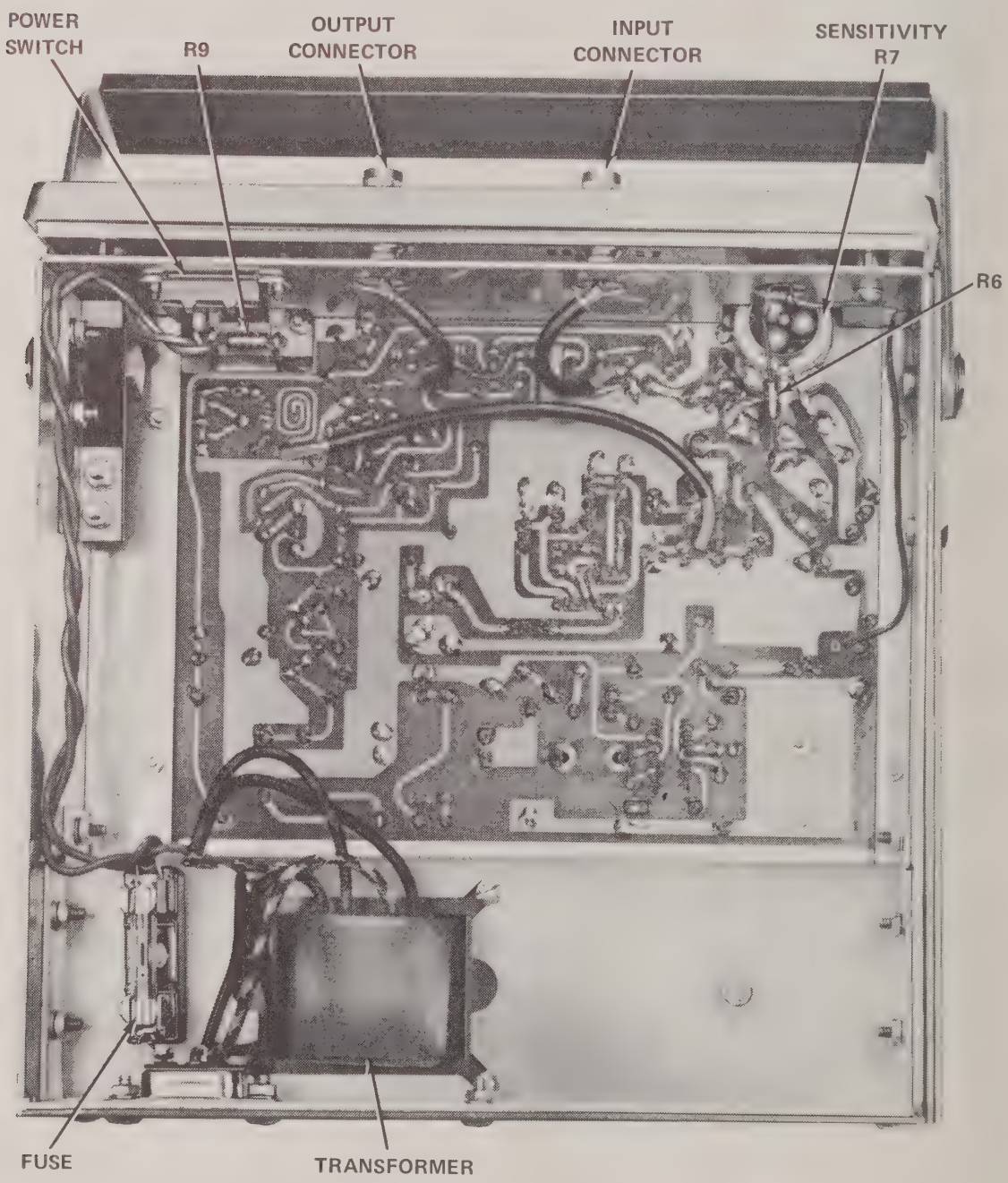


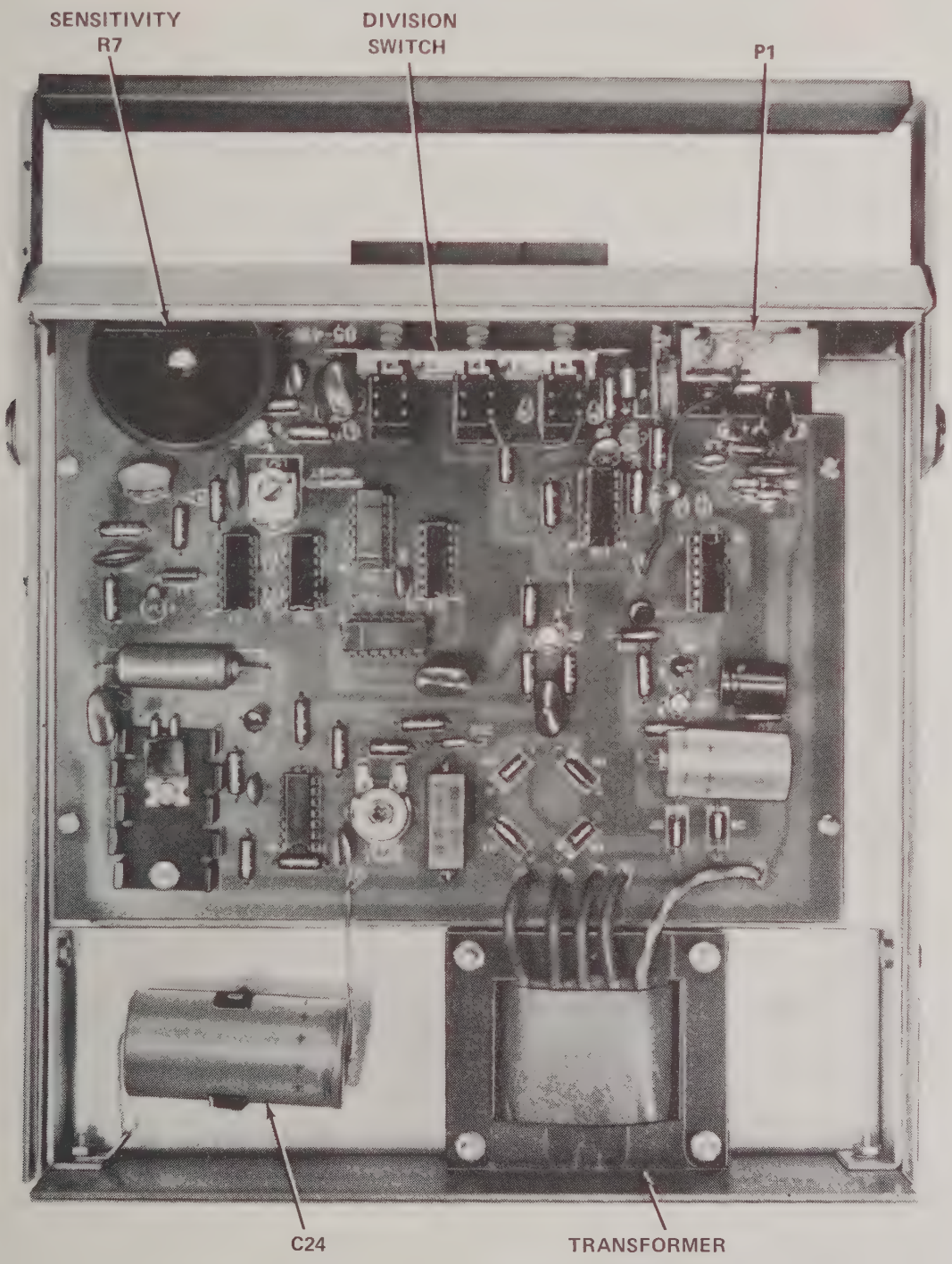
Identification Chart

COMPONENT	HEATH PART NUMBER	MAY BE REPAIRED WITH	IDENTIFICATION DRAWING
D1, D2	56-[illegible]	1N295	
D3, D4, D5, D6, D7, D8.	[illegible]	1N4002	
ZD1, ZD2	[illegible]	1N5338B 5.1 VOLT, 240mA ZENER	
ZD3	[illegible]	1N825A 6.2 VOLT, 7.5mA ZENER	
Q1	417-175	TA2911	
Q4, Q6	[illegible]	2N3393	
Q2, Q7	417-154	2N2369	
Q3	[illegible]	[illegible]	
Q1	417-258	[illegible]	

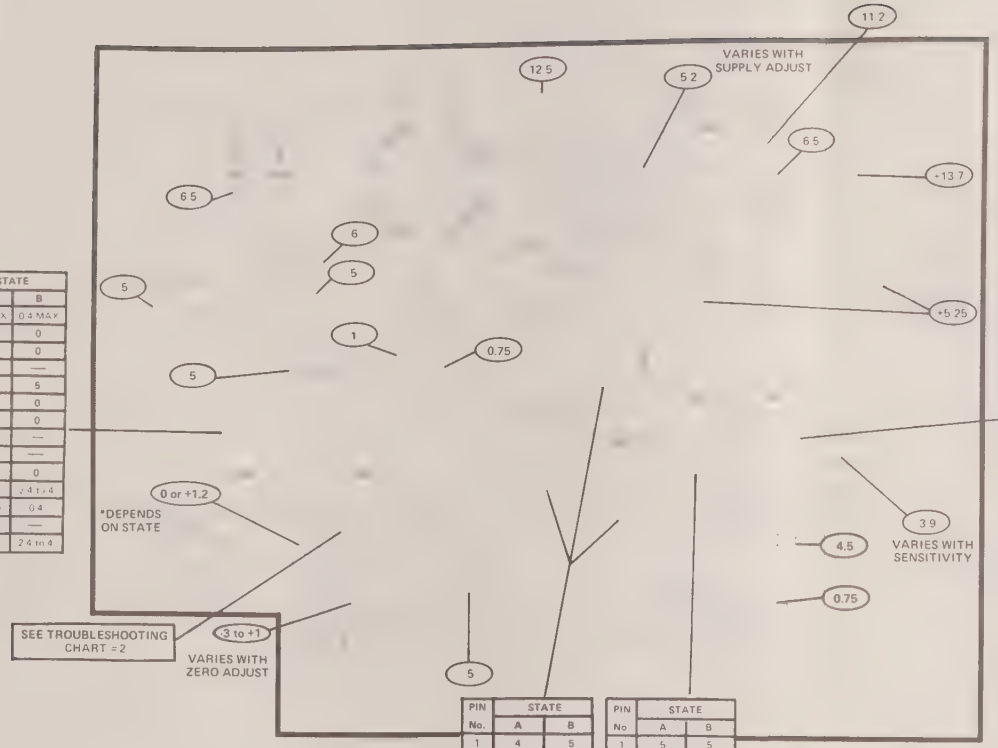
NOTE DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. THE CATHODE END OF THE DIODE IS MARKED WITH A BAND OR BANDS ALWAYS POSITION THIS END AS SHOWN IN THE PICTORIAL.

CHASSIS PHOTOGRAPHS




SENSITIVITY
R7
DIVISION
SWITCH
P1
C24
TRANSFORMER

VOLTAGE CHART



PIN No.	STATE A	STATE B
1	0.4 MAX	0.4 MAX
2	0	0
3	0	0
4	—	—
5	5	5
6	0	0
7	0	0
8	—	—
9	—	—
10	0	0
11	0.4	2.4 to 4
12	2.4 to 4	0.4
13	—	—
14	0.4	2.4 to 4

PIN No.	STATE A	STATE B
1	4	5
2	4	5
3	4	5
4	4	5
5	4	5
6	5	4
7	0	0
8	5	4
9	3.5	4.5
10	3.5	4.5
11	3.5	4.5
12	3.5	4.5
13	4	5
14	4	5

PIN No.	STATE A	STATE B
1	4	5
2	0	0
3	4-5	4-5
4	0	0
5	4-5	4-5
6	4-5	4-5
7	0	0
8	0	0
9	0	0
10	0	0
11	4-5	4-5
12	0	0
13	5	4
14	5	5

PIN No	STATE A	STATE B
1	5	5
2	5	4
3	4	5
4	—	—
5	—	—
6	0	0
7	0	0
8	4-5	4-5
9	—	—
10	4	5
11	4	5
12	5	4
13	—	—
14	5	5

VOLTAGE CHART
(VIEWED FROM SCREEN SIDE)

NOTES:

1. All voltages are dc and taken with a high impedance voltmeter from the point indicated to chassis ground. Voltages may vary ±20%.

2.* IC voltages have an A and B state of logic.

   A. Sensitivity control adjusted to 3.5 V at pin 9 of IC1.

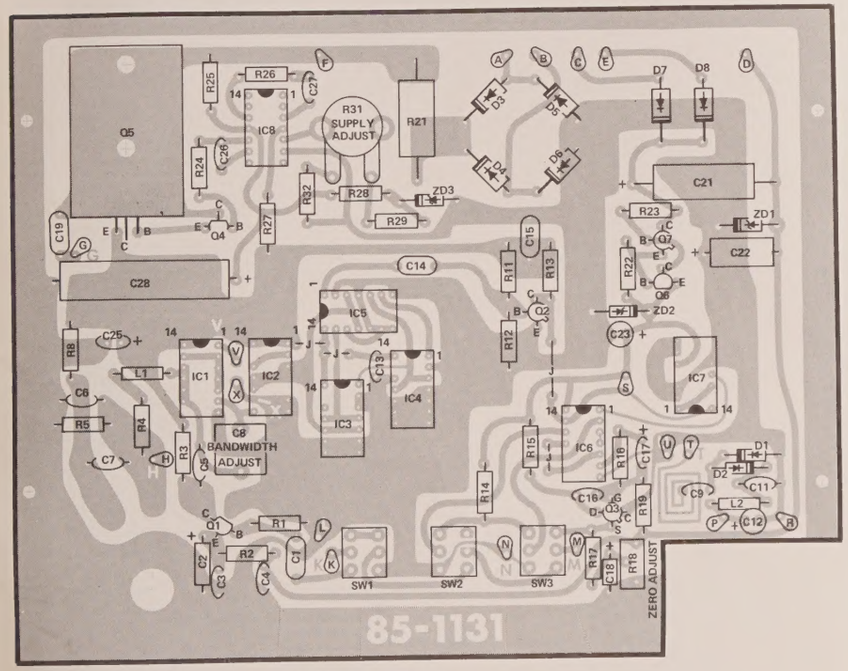
   B. Sensitivity control adjusted to 4.5 V at pin 9 of IC1.

NOTE: 4-5 means this voltage can be either 4 volts or 5 volts.

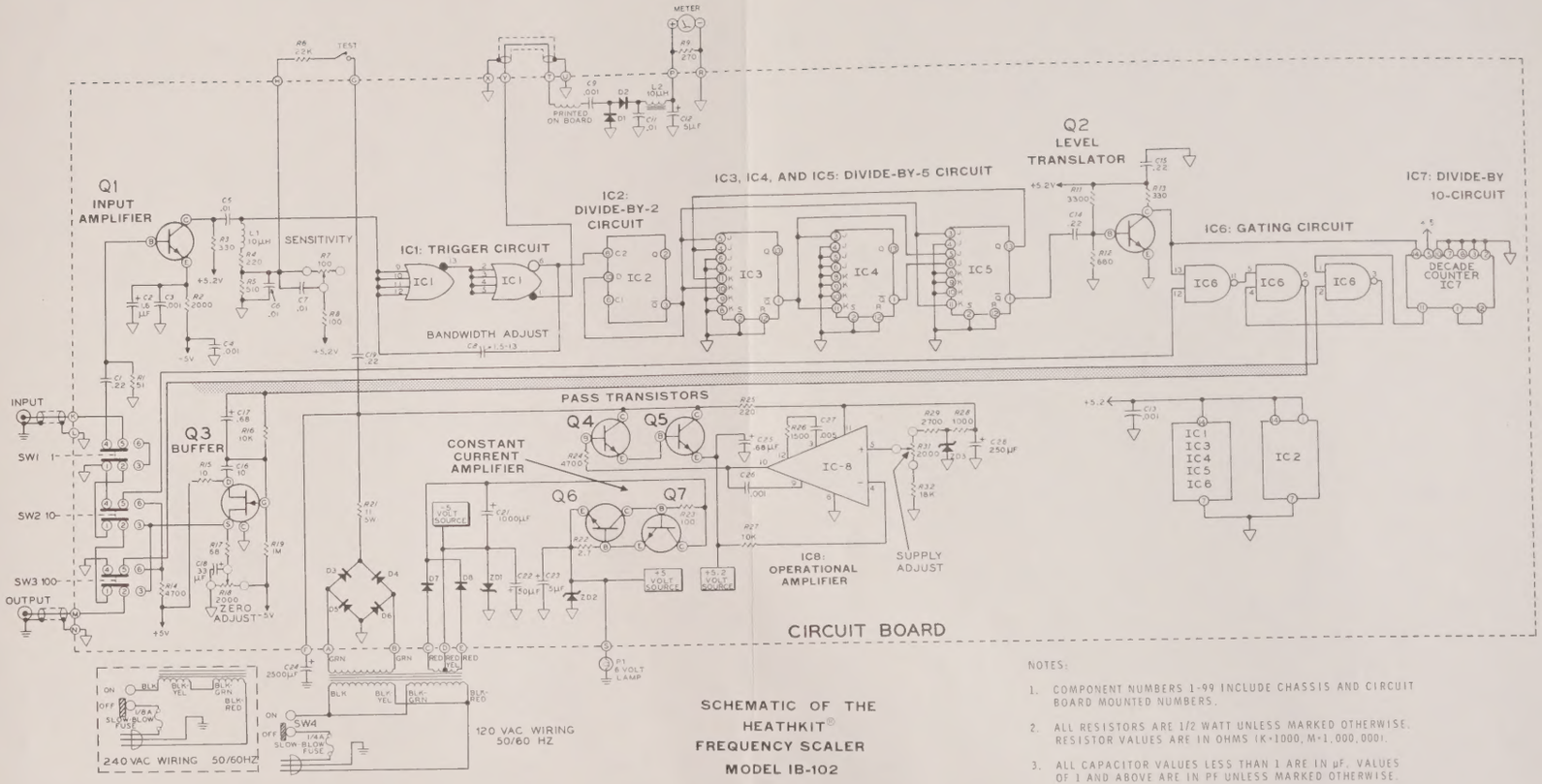
CIRCUIT BOARD X-RAY VIEW

NOTE: To identify a part shown in one of these Views, so you can order a replacement, proceed as follows:

1. Note the identification number of the part (R-number, C-number, etc.).
2. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part (for example: 22 kΩ, .05 μF, or 2N2712) will also appear near the part.
3. Look up this Description in the Parts List.



(VIEWED FROM FOIL SIDE)



SCHEMATIC OF THE HEATHKIT® FREQUENCY SCALER MODEL IB-102

NOTES:

1. COMPONENT NUMBERS 1-99 INCLUDE CHASSIS AND CIRCUIT BOARD MOUNTED NUMBERS.
2. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1000, M=1,000,000).
3. ALL CAPACITOR VALUES LESS THAN 1 ARE IN μF. VALUES OF 1 AND ABOVE ARE IN PF UNLESS MARKED OTHERWISE.
4. ▽ THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.
5. ⏚ THIS SYMBOL INDICATES A CHASSIS GROUND.

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